Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING

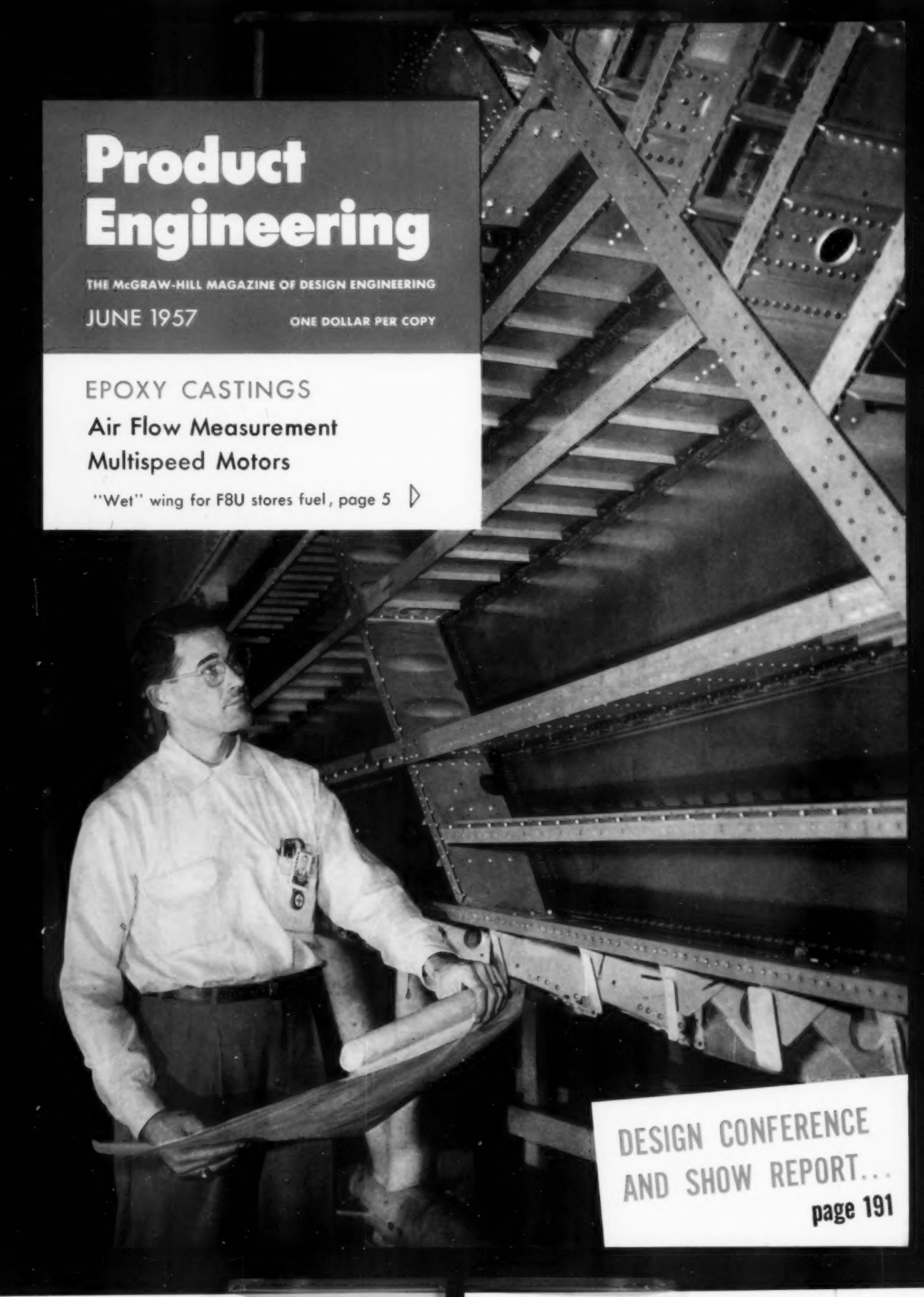
JUNE 1957 ONE DOLLAR PER COPY

EPOXY CASTINGS

Air Flow Measurement

Multispeed Motors

"Wet" wing for F8U stores fuel, page 5



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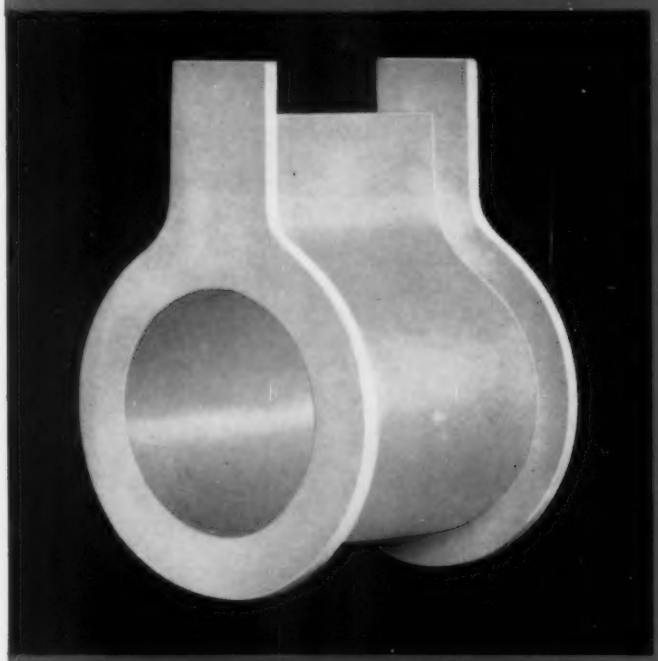
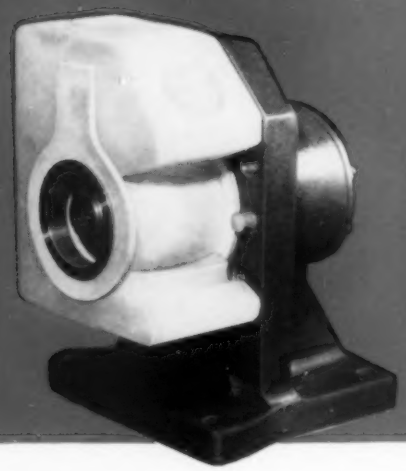
PUMPS FUMING NITRIC ACID 14.7 MILLION CYCLES





...and the Heart of this Vanton Pump is C/R Sirvene

Vanton Pump engineers knew what they wanted—a flexible liner for their unique Flex-I-Liner pump that would permit the handling of red and white fuming nitric acid, hydrogen peroxide and other strong oxidizing agents. In addition, high flexibility had to be combined with positive sealing efficiency to protect the rotor, shaft and bearing from contact with the corrosive chemicals. For almost six years Vanton engineers tested various liners and found none that could withstand these unusually severe specifications. Then they turned the problem over to C/R Sirvene engineers. They got the liner they wanted in a matter of weeks. C/R's Sirvene liner, based on the Kel-F elastomer, meets every specification and has been performing dependably for as long as 14.7 million cycles.

If you have a sealing problem—equally critical or simple—C/R Sirvene engineers can help you. They're recognized leaders in the compounding and molding of elastomers for fluid sealing and related applications. They have the research and facilities to solve your problem quickly and economically. Write them direct—or send for the informative new booklet, "Sirvene."

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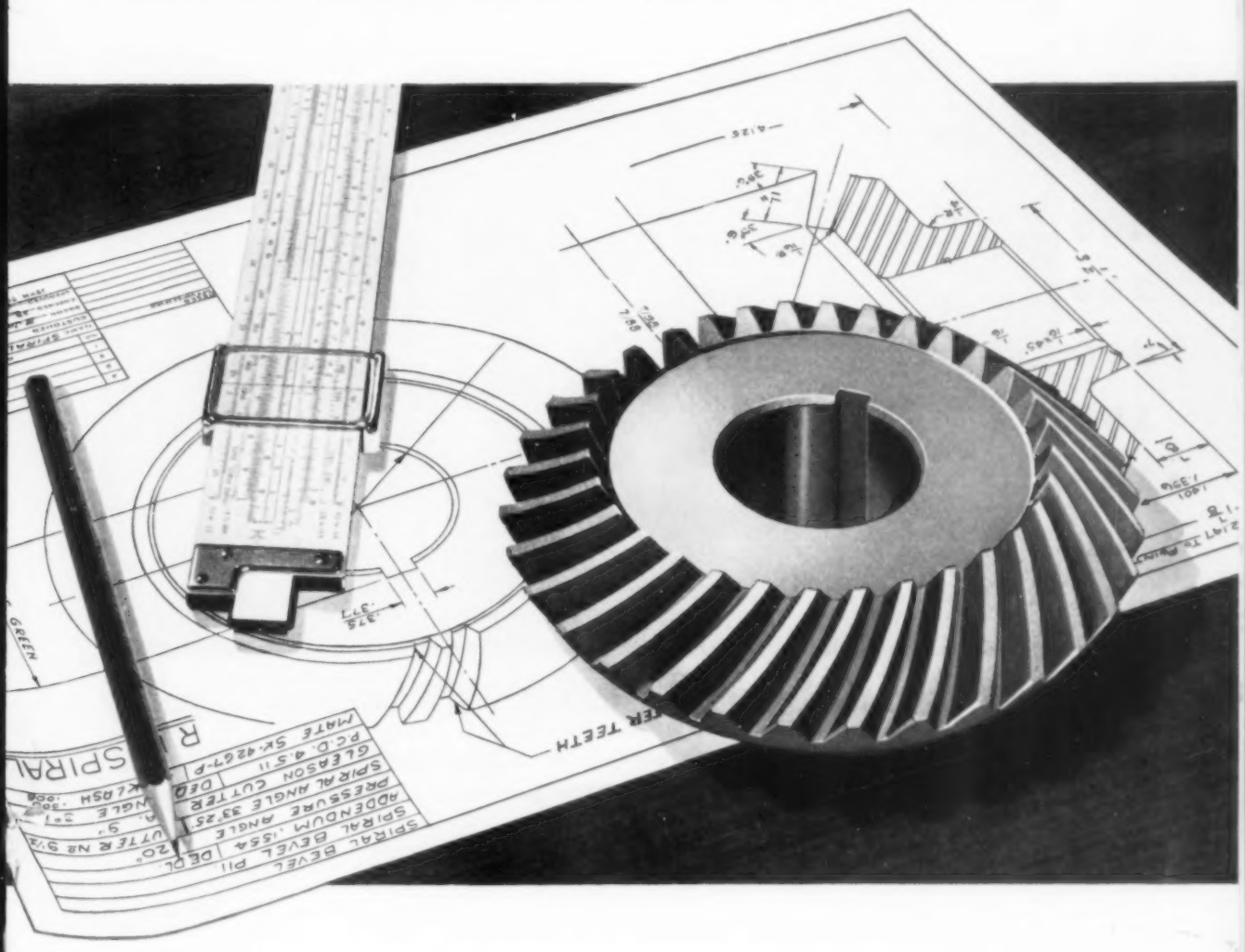

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AUTOMOTIVE GEAR DIVISION
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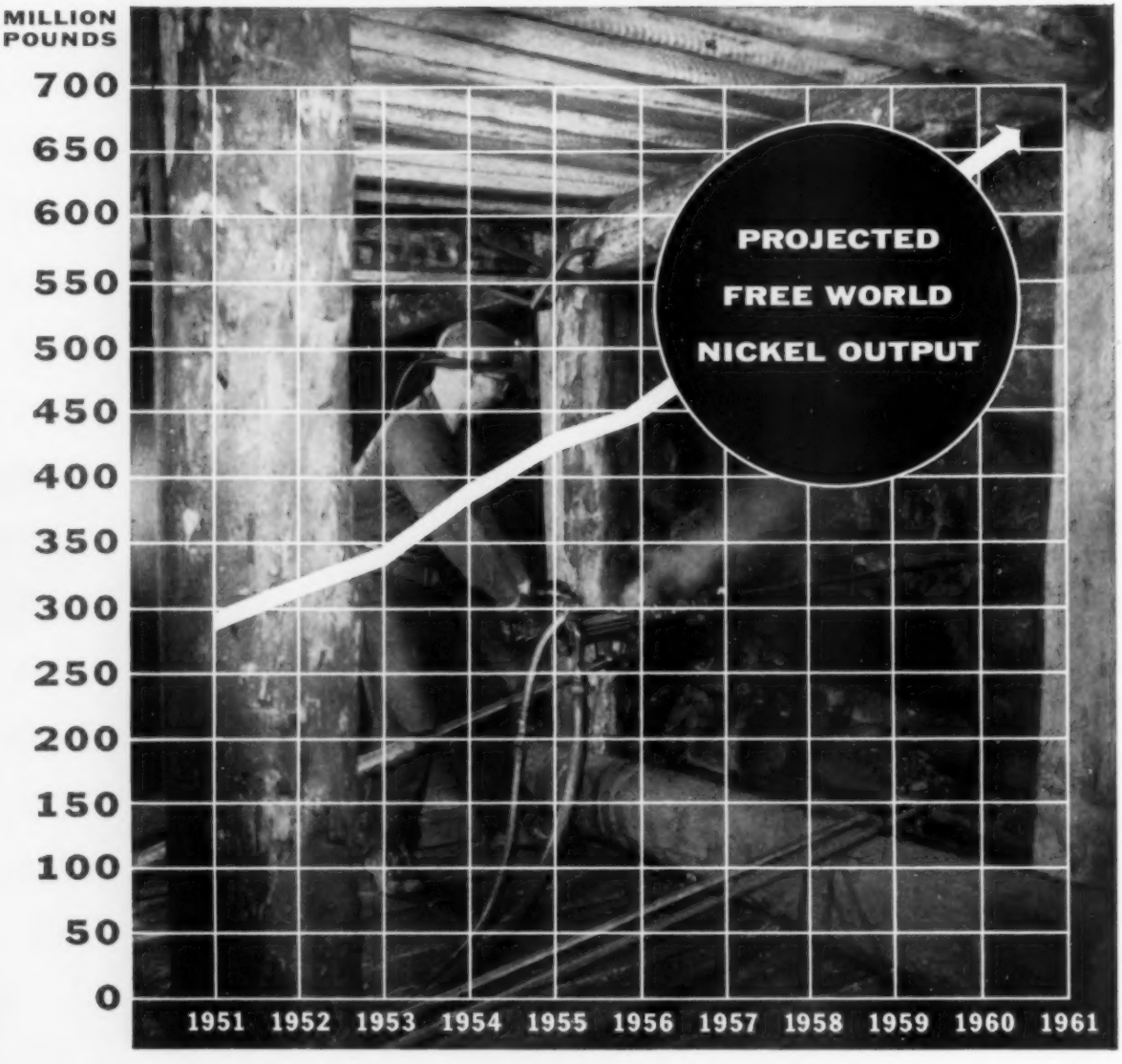
GEARS FOR AUTOMOTIVE, FARM EQUIPMENT AND GENERAL INDUSTRIAL APPLICATIONS
GEAR-MAKERS TO LEADING MANUFACTURERS



Another 50% advance in nickel industry's production capacity

Paced by Inco-Canada's new developments in Manitoba, producers put 1961 Free World nickel output at 650-675 million pounds a year—up 130% over 1951

In 1951, the nickel industry of the *Free World* produced about 290 million pounds of nickel.

Last year, the over-all output of the industry set a new record high of 450 million pounds.

This was an expansion of more than 50% in five years: a substantial production boost that indeed benefited industry, but only after vital defense and government stockpile needs were given preference.

New Inco-Canada developments help set new goals

Right now Inco-Canada, with years of exploration behind the project, is pushing construction at its new Manitoba mines: developing in the far North a new, big-tonnage nickel-producing area.

In Ontario, at the same time, Inco-Canada is continuing to expand its Sudbury capacity.

In 1961, this should lift Inco-Canada's nickel output to 385 million pounds a year. A hundred million more than in 1956!

With the steadily increasing capacity of all *Free World* producers, in the next four years nickel production should be lifted to the all-time high of 650-675 million pounds a year.

With 1961 capacity anticipated at more than twice what it was in 1951—and with continuing exploration—nickel users are assured of more nickel in their future.

The International Nickel Company, Inc., New York 5, N. Y.

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The International Nickel Company, Inc., is the U. S. affiliate of The International Nickel Company of Canada, Limited (Inco-Canada)—producer of Inco Nickel, Copper, Cobalt, Iron Ore, Tellurium, Selenium and Platinum, Palladium and Other Precious Metals

Product Engineering

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Special Armco Steel Cuts Painting Costs,

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Mill-Bonderized Armco Cold-Rolled PAINTGRIP® Steel helps streamline painting schedules, produces smoother, more durable paint finish.

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- **Longer Paint Life—Helps assure uniformly smooth paint finish that lasts several times longer than paint on untreated cold-rolled steel.**

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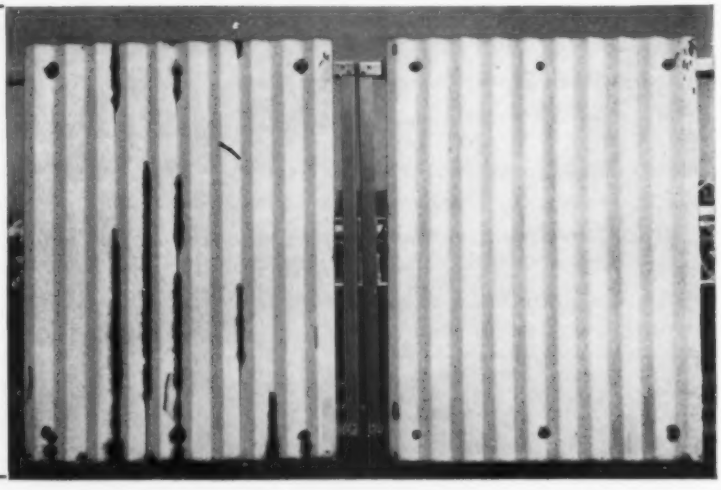
Results of two years in an industrial atmosphere. Same paint schedule for both panels. Scratched to accelerate flaking. Left—Untreated Cold-rolled steel. Right—Armco Cold-Rolled PAINTGRIP.



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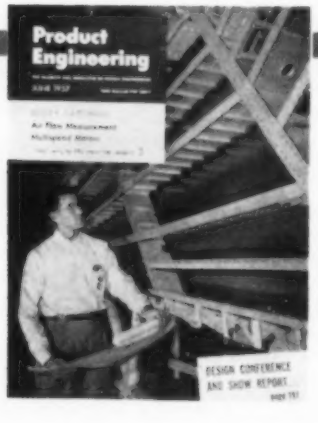
THIS MONTH'S COVER

Fuel space is provided in thin wings of Chance Vought F8U *Crusader* by "wet" wing design. Plastic sealant is injected under pressure into grooves machined in spars; sealant resists solvent and corrosive action of fuels and remain leak-proof under deformations encountered in flight. Two methods of sealing "wet" wings are compared in page 162.



Interesting to Note . . .

When An Engineer Goes Fishing

Standing on the banks of a lake high in the Colorado Rockies, Marion M. Keating, a retired mechanical engineer, was trying his hand at the ancient art of fishing. Casting his line far from shore, to where the big ones were biting, Keating realized he had a problem. To get his bait out far enough he needed a heavy sinker. Yet when he used a heavy sinker, it dropped to the lake's bottom and snagged his hook. The answer to his problem was quite simple—use a floating sinker.

Unfortunately, floating sinkers were not standard piscatorial equipment. One had never been invented. Keating finally decided that an aluminum capsule was the answer. However, more problems followed. He had to have lead appendages through which a line could be threaded. How could he join aluminum and lead inexpensively? He designed a machine similar to an automatic screw machine into which aluminum tubing is fed, rolled, rounded, creased and cut. The shells then go to a die operator who inserts a lead pellet in the shell and places it in the cavity of a die. The die is spun over a 365 F flame at 500 rpm until the molten lead is thrown to both ends of the shell, forming a hermetically sealed hollow tube. In practice, the floating sinker provides the weight for long casts, yet stays afloat long enough for the fisherman to attract the fish.

The same problem, that of handling and controlling liquid metal, must also be met in another metallurgical process—Parlanti casting. Molten metal in an aluminum mold, with careful control of the directional solidification, is a new process described on page 170.

The Birth of the Box

Perhaps the corrugated container is the most discarded of all items manufactured by industry. From the small container of cosmetics and beer cans to the larger boxes for machinery and bombs, the paper box is made to be used, then thrown away.

The first paper container dates back to the Chinese and a chap named Ts'ai Lun who supposedly invented paper in 105 AD. From paper evolved "pasteboard," a fibrous material developed in the fifteen century by a Roman printer who pasted together pages of old books. This form was manufactured commercially a century later and replaced the wooden slabs which covered the first books. Eventually, heavy layers of pulp were poured, molded and dried, forming paperboard. One of the first applications of paperboard was in the wide brims of hats

(*Continued on page 7*)

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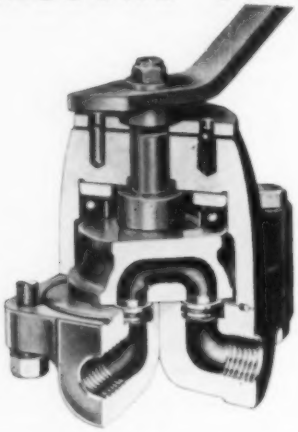

1. ***Can you shut off flow tightly?***
2. ***Can you throttle gradually?***
3. ***Can you get full flow?***

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(1500, 3000 and 6000 P.S.I.)
are leakproof and stay leakproof for years of service with little or no maintenance; no internal port to port leakage in the detented positions and, of course, no external leakage. Sealing qualities actually improve with use, due to wear compensating lapping action of "Shear-Seals."

2. You get excellent throttling, smooth action to any degree of flow without fighting the fluid pressure.

3. Quick as a quarter turn of the handle you can open the full flow (or shut it off) with surge dampening action, because the round tubular passages have no spools or poppets obstructing flow.

BARKSDALE VALVES

5125 Alcoa Avenue, Los Angeles 58, California

Ask for bulletin 5-H, -A and -W.

Interesting to Note . . . .

worn by the Quaker sect. Hatboxes and jewelry boxes were soon made of it—and a new industry was born. It was found that when three layers were glued together, with the center layer fluted or "corrugated," strength, without weight, resulted.

Robert Gair, in 1870, found that a poorly adjusted printing press in his plant was accidentally cutting the paperboard being printed for boxes. This accident led him to design the first cutting and creasing machine for the corrugated container. Many improvements in box construction, design and creasing techniques have since been introduced. A new machine which can now die-cut corrugated board as well as other rigid materials at speeds up to 60 impressions per minute is illustrated and discussed on page 152.

The Flypaper Report

A newly commissioned lieutenant was stationed at an insignificant Army base. He was assigned the usual "greenhorn" job—the base messhall. His sole function seemed to be to fill out endless pages of questionnaires, orders and reports; all supposedly necessary to insure the men a proper diet. After awhile the lieutenant became so irked with the steady stream of paper he had to forward to Washington, he decided to add a special report of his own. He mimeographed a form with a sketch of the messhall showing the positions of 20 strategically located flypaper ribbons, each with its own code number. Daily he sent in a report on the number of flies trapped on each ribbon.

Several weeks passed, then one of his fellow officers asked him if he knew what the Pentagon meant by a "flypaper report"? It seemed that Washington had thought a census of dead flies an excellent means of rounding out its information on field activities. The Pentagon now wanted similar reports from other units as well.

The government has lately become conscious of the expense of paper work. Such groups as the Hoover Commission have suggested ways to save money by cutting the flood of paper. Industry is also increasingly aware of this problem. Ben S. Graham, director of methods research, Standard Register Co., has said that half of industry's $80 billion annual bill for paper work is unnecessary. But still the cost of putting things on paper skyrockets. Some of the reasons for drafting-cost growth over the past twenty years are given in an article beginning on page 166.

Master of the Motor

The year was 1810 when a 13-year-old lad persuaded the notable theatrical director, John Bernard, to take him on as a student. For the next two years, the boy devoted himself to a career as an actor. Then fate entered the life of young Joseph Henry and demanded that he make the most important decision of his life. Henry's health failed and forced him into an Albany hospital. While regaining his strength he happened to pick up a book of science that captured his entire interest. The book so aroused young Henry that he abandoned his several years of acting experience and decided to become a scientist.

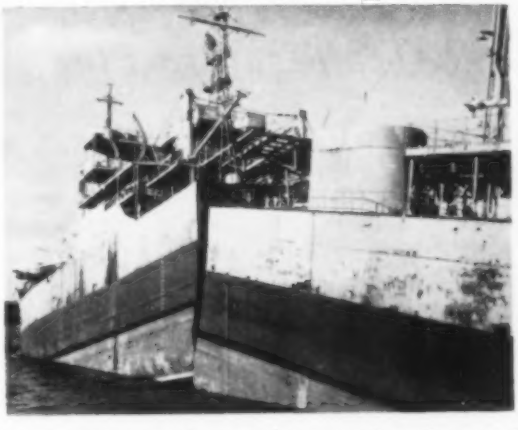
Henry had to educate himself with the aid of a public library and a local night school. At the age of 29, the farmboy-turned-actor accepted a professorship at the Albany Academy and four years later joined the staff at Princeton University. In his desire to understand electro-magnetic induction more fully he delayed publishing his findings. This delay cost him much glory, as Faraday in England published similar experiments while Henry was completing his data.

Undismayed, Henry continued his work with electricity, and in his lifetime laid the foundation for our modern transformer and the electric motor. One of the basic problems in the use of electric motors is in starting. The first major change in standards for motor starters is described on page 189.

Split Ships and Molasses

Before the French Revolution, the effects of metal failure had been observed but never understood. Ductile wrought-iron tires on the wheels of stage coaches broke after a predictable period of service. Why should these iron rings suddenly shatter like pieces of glass? The French engineer, Jean Poncelet, dubbed this strange effect *fatigue*.

The results of fatigue can sometimes be disastrous. In 1914, a large storage tank in Boston burst, spewing 2.3 million gallons of molasses onto the streets. Aside from the property damage that ensued, twelve people were drowned, and scores were injured.



The results of fatigue can be costly in other ways. In December 1947, the tanker *Ponaganset* (pictured above) was resting in her berth in Boston harbor. Suddenly a loud, rifle-like report rent the air and the ship broke cleanly in two. During the second World War, metal fatigue of this sort was responsible for the loss of six ships (plus some 964 casualties) out of the 4700 ships built by the Maritime Commission, according to the *General Electric Review*.

This type of failure, caused by low-temperature notch sensitivity, is but one of several types of material fatigue. Another, thermal stress fatigue, is the subject of an article appearing on page 175.

Proof of 550° Performance...

New "Roast-Meter" Uses Mallory High Temperature Plug and Jack

An improperly cooked roast of beef, just when important dinner guests were in for a special dinner, probably created the idea for the "Roast-Meter" . . . but it took Mallory ability and ingenuity to make this new kitchen aid a reality.

A prong is inserted into the heart of the roast—the flexible cable attached to this prong is plugged into a jack on the oven wall. An accurate reading of the inside temperature of the roast is given on an external indicator.

The manufacturer's problem was to find a plug and jack assembly that would stand up under severe operating conditions, especially under high temperatures. The performance specifications called for a 15 to 20 year life potential—in a temperature environment that might often reach as high as 550°F.

To meet this challenge, Mallory adapted their standard #85 two-circuit plug to brass-nickel plate construction with ceramic insulation. A special terminal holds the flexible cable connected to the prong. The jack assembly was redesigned from the standard #702B, and uses Mica-Ramic insulation.

If your requirements for product design call for a similar plug and jack assembly capable of withstanding high temperatures of household or industrial applications, specify Mallory #85 Hi-Temp plugs and #702B Hi-Temp jacks. For any components capable of withstanding unusual operating conditions, see a Mallory engineer—ask for Mallory assistance in solving all your special component problems.

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Developments

To Watch

PRINTED CIRCUITS WITHOUT THE ETCHING . . . .

. . . . or plating processes offers a big boost to the economic mass production of this product, according to Rogers Corp., Rogers, Conn. Their method: a phenolic impregnated cellulose sheet material called RM-2035, which can be molded to a 3-dimensional shape, with tapered holes for component lead insertion. Rolled copper foil, either coated with an adhesive or in combination with a separate adhesive film sheet, is fed beneath a heated die plate. As the tool blanks the foil and adhesive pattern through a die plate onto the RM-2035 beneath, the heat superficially bonds the copper circuit pattern to the uncured material. The excess copper is stripped away, and a thin, protective cover sheet of RM-2035 is placed over the circuit to protect it from short circuiting. Only the contact points are exposed. The two sheets are put into mold cavities and molded at 2000 psi and 310-325 F for 2 min to form a homogeneous unit. The molded parts should be after-baked for 30 min at 265 F to get good electrical characteristics. When fully cured, the sheet has the electrical and mechanical characteristics of NEMA grade XXXP. Uncured sheets are supplied in sizes 48 x 66 in., in thicknesses from 0.031 through $\frac{1}{8}$ in. Epoxy resin is applied to both surfaces. Some of the advantages of this printed circuit technique: the molded board may be tapered in thickness; reinforcing ribs may be added to strengthen thin sections; holes from 0.030 in. dia can be molded into any thickness base, and may be tapered or stepped in depth; terminal pins and other hardware can be molded into the board; low initial investment in equipment; and adaptability to various molding techniques. Printed patterns on both sides of the insulating base also are possible. Besides molded circuits and printed wiring devices, the process lends itself to the production of terminal boards and sliding contact switches.

Another technique for mold construction under study, to determine its adaptability to RM-2035, is the pressure casting process, using a beryllium-copper alloy. From a machined template or hob, 10 to 20 mold cavities can be reproduced in a castable alloy quickly and inexpensively, thus eliminating the need for machining each cavity of a multi-cavity mold.

PLASTIC FITTINGS WITH BUILT-IN HEATING COILS . . . .

. . . . is one of the more promising methods for hot welding high density polyethylene pipe presently being investigated by the Allied Chemical & Dye Corp., 61 Broadway, New York 6, N. Y. Several turns of resistance wire are molded into the plastic around the fitting opening. The projecting terminals are connected to a battery which supplies heat of about 110 F for several minutes. The inserted plastic pipe is then given a slight twist to upset the slightly softened material and complete the seal. If successful, this process will replace the present method of using a metallic clamp to attach the pipe to a rigid plastic fitting.

NICKEL-FERRITE REPLACES NICKEL . . . .

. . . . in a new magnetostrictive material for use in ultrasonic transducers. Developed at the U.S. Naval Ordnance Lab., White Oak, Silver Spring, Md., the material consists of nickel ferrite in which cobalt atoms replace about 2.5% of the nickel atoms. An additional 3 to 6% of the nickel atoms are replaced by

(*Continued on page 10*)

ferrous iron. An 87% saving of nickel is possible when this ferrite is used in place of nickel for transducer construction. Because of the large volume resistivity of the ferrite, eddy current losses which limit the operating frequency of magnetostrictive alloys are no longer a problem. The ferrite can be formed by powder metallurgy techniques into its final shape, simplifying fabrication.

STARTING AS A NON-CRYSTALLINE GLASS . . . .

. . . . Corning Glass Works' new basic material called Pyroceram becomes in its final form a hard, nonporous crystalline material. It is harder than a comparative steel of a Rockwell 65 C, and lighter (sp. gr. 2.4) than annealed 77 S aluminum alloy (sp. gr. 2.8). Corning has developed over 400 different compositions of this material, covering a wide range of physical properties. It can be made with thermal expansions ranging from —7 to 200 x 10^{-7} per deg C, and can be opaque or transparent. Corning reports electrical insulating properties better than those of good commercial dielectric ceramics. The dielectric constant ranges from 5.61 to 8.31 (compared with 8.81 for alumina) and a dielectric loss factor of 0.0012 at 10^{10} cps (compared with 0.0132 for alumina). The first use of the new material will be as a radome for guided missiles.

ULTRA-HIGH-STRENGTH STEEL . . . .

. . . . with enough ductility and impact resistance to be used in aircraft components has been developed by the National Bureau of Standards, Washington 25, D. C., for the Navy Bureau of Aeronautics. When oil quenched from 1650 F and double tempered at 400-500 F, the new steel has a: hardness of 53 Rc; ultimate tensile strength, 285,000 psi; yield strength (0.2%), 235,000 psi; 10% elongation in 1.4 in.; 35% reduction of area; Charpy (V-notch) impact at room temperature and —40 F is the same, 16 ft-lb. As constituents, the steel has: 0.40% carbon; 0.75% manganese; 1.60% silicon; 1.80% nickel; 0.85% chromium; 0.30% molybdenum; 0.10% titanium; and 0 to 0.002% boron.

ALUMINUM MIGHT REPLACE TIN . . . .

. . . . as a coating on the mild steel plate commonly used in food containers and closures such as bottle caps. The use of such a substitute shows promise as a practical and economical production process, according to Crown Cork & Seal Co., Inc., and National Research Corp., who are conducting research under a joint venture at the latter's laboratories, 70 Memorial Drive, Cambridge 42, Mass. The aluminum coating is deposited by vacuum thermal evaporation, and a continuous coater has been built which takes steel sheet from atmospheric pressure to high vacuum where aluminum is applied, and returns it to atmospheric pressure. National Research says that the end product has corrosion resistance equal to that of tin plate, it can withstand the abrasion and deformation of the drawing operation, and it retains a bright appearance. In addition, economic studies of the process show a good cost reduction potential, besides freeing a large segment of the container field from foreign tin supplies.

A BATTERY-POWERED, TRANSISTORIZED MILLIAMMETER . . . .

. . . . designed to measure alternating currents in the audio-frequency range without circuit interruption has been developed at the National Bureau of Standards, Washington 25, D. C. Featuring low current requirement and a wide frequency response, measurement is made by clamping a small magnetic probe around the

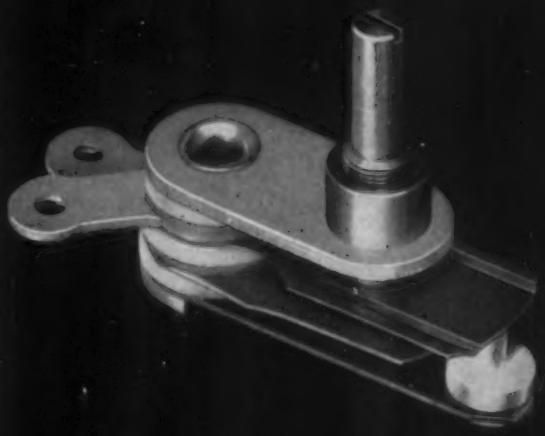
(*Continued on page 12*)

DESIGN OF THE MONTH

in Coffee Makers

Crown Jewel

by **CORY**



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AA-4851

conductor that carries the unknown current, and reading the meter indication. A voltage proportional to the unknown current is supplied to an external jack to present the current waveform on an oscilloscope. Ranges of the small, experimental milliammeter are: 0.2; 2; 20; and 200 ma full scale calibrated in sinusoidal rms values. Accuracy is: ±10% of full scale, 150 to 50,000 cps, any range; and, ±10% of full scale 50 to 100,000 cps, 0.2 ma range. Equivalent input noise is about 20μa; battery life is approximately 300 hr, intermittent duty.

A LOW THERMAL EXPANSION CERAMIC . . . .

. . . . which can withstand extreme thermal shock without cracking, crazing, or distortion, offers many applications in the high temperature field. A modification of aluminum silicate, the new material called HT-2 has good properties at temperatures up to 2100 F. In tests, $\frac{3}{8}$ in. thick sections have been heated to 2000 F and quenched in water repeatedly with no signs of cracking or appreciable warpage. Technion Design & Mfg. Co., Inc., 262 Mott St., New York 12, N. Y., developers of the new material, claim that the key to this high thermal shock resistance is its low linear thermal expansion of 10 x 10^{-7} in./in./deg F at 2000 F. Other properties: weight, 0.062 lb/in.^{3}; compressive strength, 30,000 psi; modulus of rupture, 5000 psi; hardness, 5 Mohs scale; dielectric strength, 45 volts/mil in a $\frac{3}{8}$ in. section. HT-2 ceramic can be manufactured by all conventional methods, including dry pressing, extrusion, and slip casting. Parts measuring more than 60 sq in. are too large for dry pressing. Undercuts and orifices must be put in after firing. Threads can be pressed in the parts, but should be of the rough series. One HT-2 application is as an electrical insulator for thermo-couple leads on jet engine test stands. Here the engine cycles from 1600 F to room temperature in 5 sec. HT-2 ceramic materials are in the cost range of copper ingot.

AND IN ADDITION . . . .

. . . . Something new in expositions is the Technical Personnel Recruiting Exposition scheduled for Chicago's Sherman Hotel the 8th to the 12th of this month. Presented in conjunction with the National Technical Career Conference, exhibits by research and manufacturing organizations will be featured. . . . A comprehensive Handbook of Mathematical Tables from the most elementary through almost the entire field of transcendental functions is being prepared by the National Bureau of Standards, and will be finished by the end of 1958. The book is being supported by the National Science Foundation and will have 750 pages of tables, 50 pages of graphs, and 200 pages of text. . . . Gamma rays from radioactive cobalt are being used to detect and control the level of molten titanium in a "cold hearth" arc furnace designed to prepare the purified titanium at Westinghouse Electric's metals development plant at Blairsville, Pa. If the ingot in the furnace is too high, it blocks the beam of gamma rays; if the ingot is too low, the beam is uninterrupted. These changes in the amount of gamma radiation are used to bring the ingot to the correct position (within 1/100 in.) in the furnace for proper operation. . . . A 99% "native" alloy steel for jet engine bearings operating at high temperature (500 F) uses no imported tungsten or cobalt. Made by the Bower Roller Bearing Div. of Federal-Mogul-Bower Bearings, Inc., Detroit, Mich., the steel's principal alloying elements are 3% nickel, 1.5% chromium, and 5% molybdenum. . . . The Aluminum Co. of Canada, Ltd., has introduced an aluminum sheet product which is color anodized on one side and available in coils up to 48 in. wide. Thicknesses from 0.020 to 0.064 in. are available. The process is reported to be less expensive than conventional anodizing methods, and has gold, yellow, black, blue and green, plus natural colors for exterior application. . . . Aluminum has been taken off List B of the Defense Dept. Conservation List B, allowing unrestricted use of it in military equipment design.

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NEW fatigue-proof STEEL BAR

..the bar that has HIGH STRENGTH without heat treating

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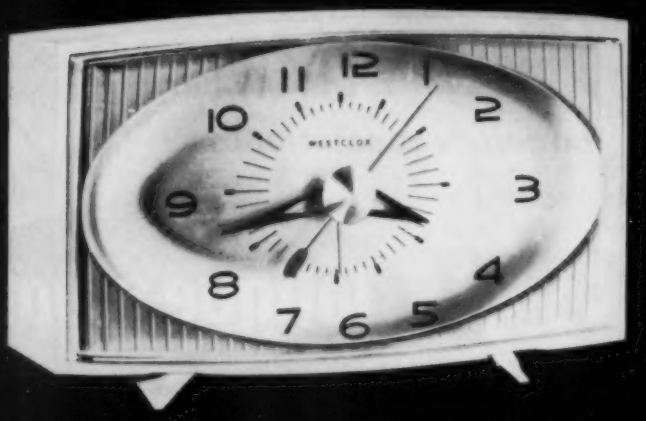
HIGH-IMPACT THERMOPLASTIC RESIN

in the new, nonbreakable WESTCLOX *Ellsworth* Electric Alarm Clock Case?



The answer is simple:

WESTCLOX Division of General Time Corporation chose CYCOLAC for their "Ellsworth" electric alarm clock case because CYCOLAC gave them the sturdy, rigid toughness, and high impact strength their specifications demanded; plus the light weight, bright glossy colors and excellent moldability they sought for the "Ellsworth." CYCOLAC proved the ideal choice.

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- Profile Extrusions
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CYCOLAC has the very basic material properties you are looking for: Rugged toughness plus light weight . . . Bright colors accented by high gloss . . . Excellent impact-resistance combined with a high in heat-distortion temperature plus a low brittle point.

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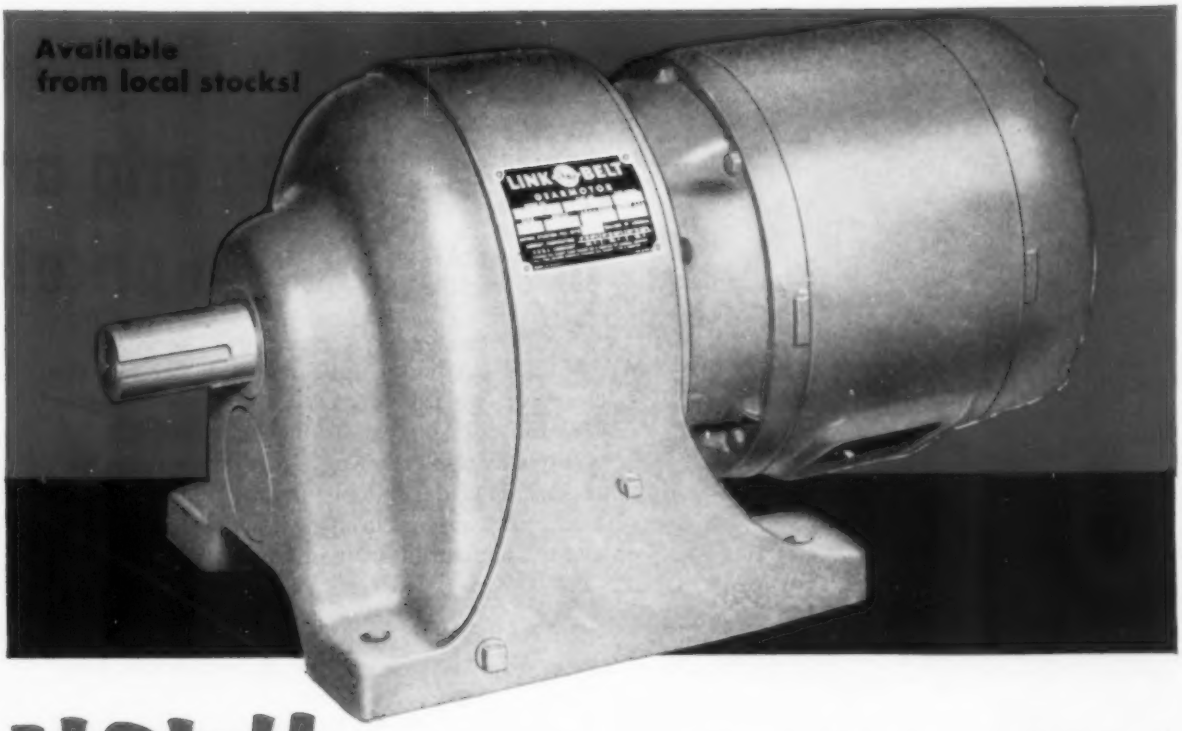
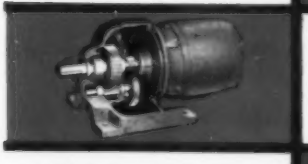


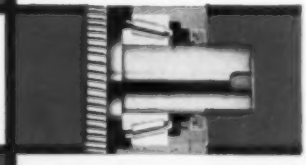
NOW! Speed reduction with space reduction

UTMOST COMPACTNESS is provided by flanged connection of motor to gear drive.

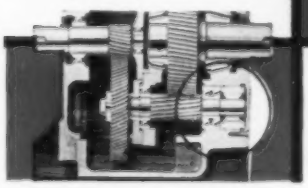
STANDARDIZED FLANGE (one size per motor) permits use of more universally applicable motor.



BUILT-IN ALIGNMENT is provided through use of the rabbet-fit NEMA motor.



EFFECTIVE SEALS at all shaft openings keep oil in and prevent dirt from entering housing.

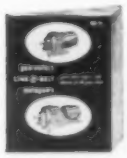


INTEGRAL BACKSTOP to prevent reverse rotation. Can be installed at any time without additional parts or modifications.

LINK-BELT GEARMOTORS maintain positive alignment with flange-mounted NEMA motors

Here's space-saving speed reduction that's made-to-order for tight drive locations. First, because the speed reducer itself is extremely compact, thanks to Link-Belt's advanced gearing methods. Second, the motor is flange-mounted, with no need for coupling devices.

In response to the tremendous demand for these new Gearmotors, Link-Belt can now offer delivery from stock for sizes up to 30 hp, speeds from 280 down to 6 rpm. For details, contact your Link-Belt office.



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ALLENPOINT will give you a bulldog grip at no premium in price!

Allen's scientific redesign of the cup diameter on set screws gives greatly increased resistance to *withdrawal* torque. You can count on Allenpoint Set Screws to stay tighter longer, under heavy strain and vibrations. This dependable premium performance of Allenpoints is yours to use without increasing the cost of manufacturing your products.

Uniform Class 3A Threads

Allenpoints' smooth, uniform threads prevent off-lead conditions like Fig. 1. With Allenpoints, you have full, even contact between the engaging flanks of the threaded members (Fig. 2) —and a tight friction lock over the entire length of the Allenpoint Set Screw.

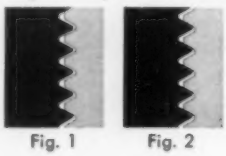


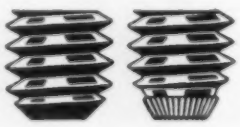
Fig. 1 Fig. 2

Strong, clean, deep sockets allow full wrenching leverage

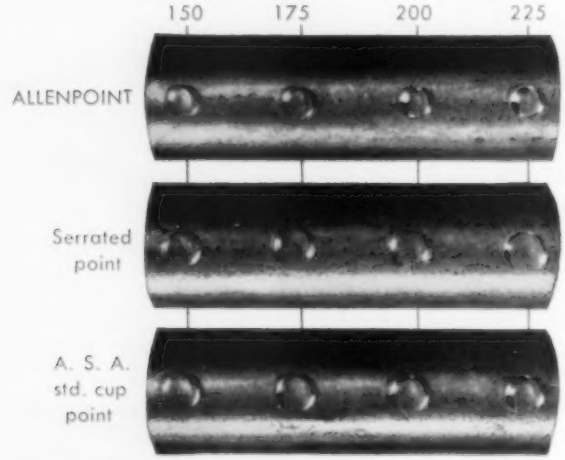
Sockets of Allenpoint Set Screws are cold forged to produce a deeper, smoother socket. No broach chips to interfere with proper seating of the key. This "pressur-forming" preserves the long steel fibers throughout the length of the screw—stronger walls allow maximum tightening torque.

One more full thread on ALLENPOINTS!

Allenpoint Set Screws have one more full thread than serrated point set screws. That means more holding power—especially important when you're using short lengths.



ALLENPOINT's performance compared for you



These actual-size, unretouched photographs show the cup pattern made by Allenpoints, serrated points, and A.S.A. standard cup point set screws in a 3/4" steel shaft. At each degree of tightening force, Allenpoints make a full circle pattern, penetrating deeper for greater holding power.

We'll be glad to send you more information and samples of Allenpoint Set Screws and other Allen Socket Screw products.

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What's more, you give your product new sales-advantages: Direct-reading digits, instead of hard-to-read dials and verniers . . . instant remote indication if needed . . . up-to-the-minute performance records that serve as a basis for production-*Count*rol, and as proof of your performance guarantee. So don't let counters take a back seat in your new-product plans. *Design them in, when you begin* . . . it pays in many ways. Do you have the newest Veeder-Root Catalog? Write

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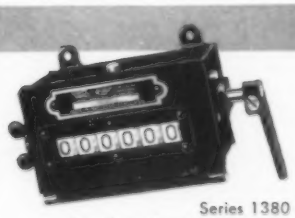
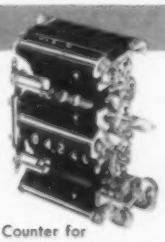
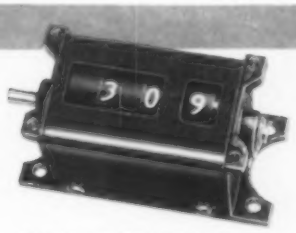


Series 1380
Box-Type Counter (Ratchet, Revolution, or Geared)

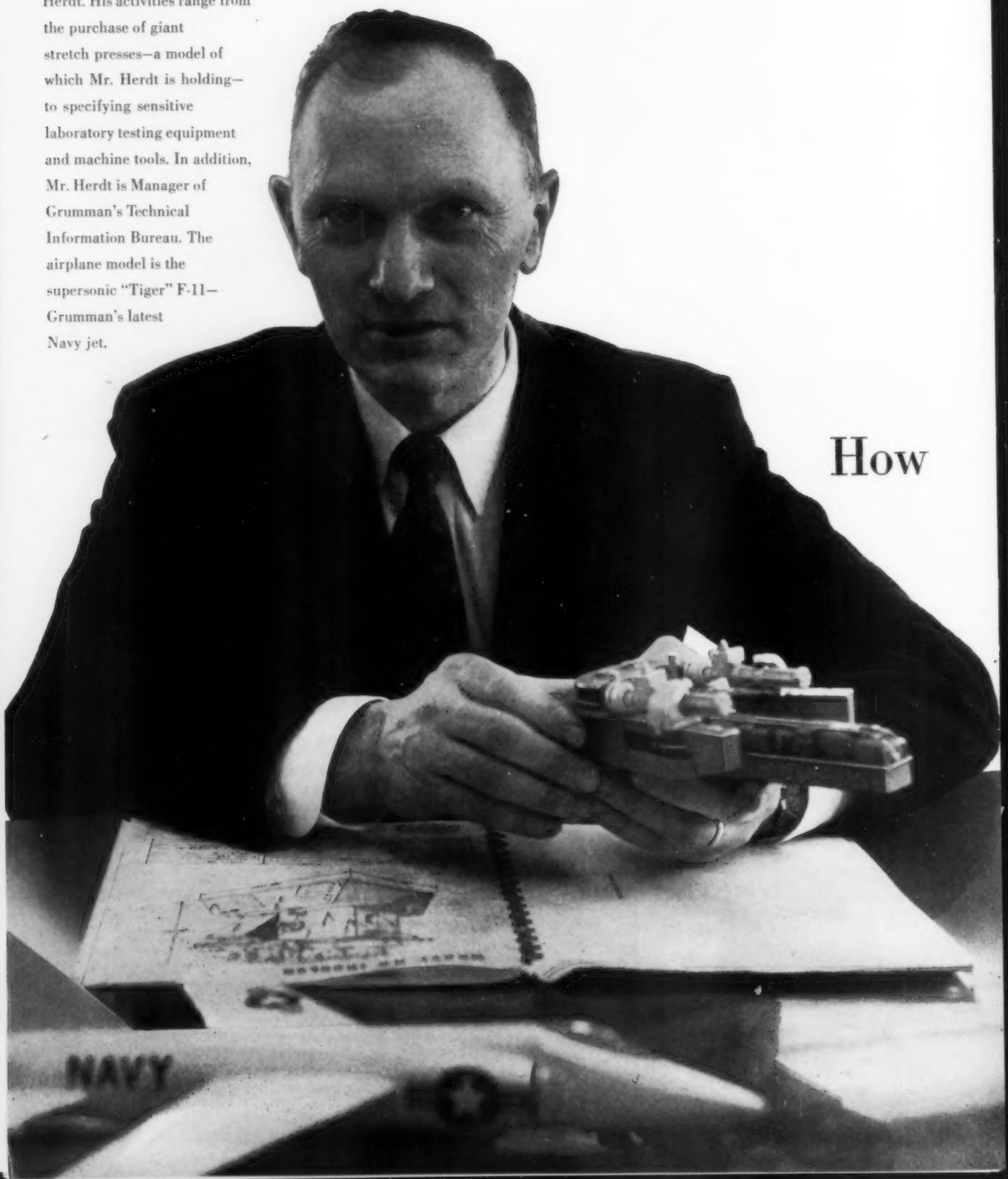


4-bank Counter for Radio Transmission Equipment



360-degree Bearing Counter

Grumman has long been a major producer of the U.S. Navy's line aircraft—and at Grumman, whatever concerns "manufacturing the product" concerns Gilbert R. Herdt. His activities range from the purchase of giant stretch presses—a model of which Mr. Herdt is holding—to specifying sensitive laboratory testing equipment and machine tools. In addition, Mr. Herdt is Manager of Grumman's Technical Information Bureau. The airplane model is the supersonic "Tiger" F-11—Grumman's latest Navy jet.



How

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how durability of ARMASTEEL® PISTON applications in

In thousands of applications—in millions and millions of hours of operation—Detroit Diesel engines with ArmaSteel pistons have proved repeatedly their ability to stand up under any task.

In the original design of the Series 71 Detroit Diesel engine in 1937, much thought was given to the piston material. Aluminum pistons were susceptible to burning out. Gray iron, even the high alloy types, did not have sufficient strength or endurance for diesel service. Finally after exhaustive tests Central Foundry's pearlitic malleable iron—ArmaSteel—was found to be the ideal material. It did not burn out and it had exceptional endurance.

Through the years the horsepower of the Series 71 periodically increased until today it has twice the power of the original engine and this without increasing the size of the engine or the number of cylinders. And ArmaSteel Pistons in spite of the higher operating loads and extreme temperatures, are still performing flawlessly. As a result, ArmaSteel pistons are now standard in all Detroit Diesel engines.

As in these dependable Detroit Diesel engines, your product may be improved by the advantages of ArmaSteel's unmatched qualities of machinability, uniformity, high yield strength, excellent bearing properties . . . and the other remarkable characteristics of this pearlitic malleable iron.

This Diesel piston is cast and machined from grade 86 M ArmaSteel which provides a fine combination of high strength and machinability. Tensile strength is 70,000 psi. (double that of grade A cast iron). Yield is 48,000 psi. Because of ArmaSteel's structure the machinability rating is 95% that of S.A.E. 1112!

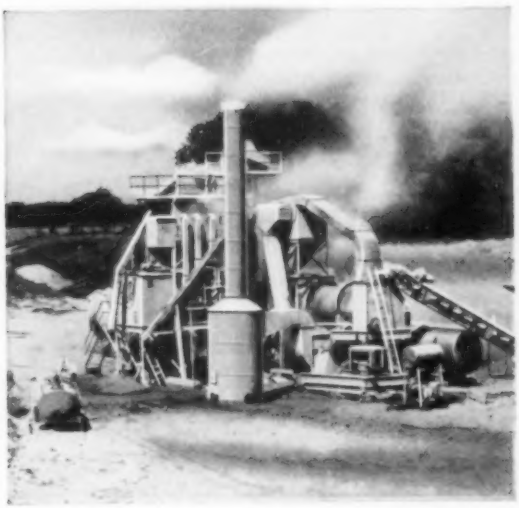
Heavy-duty scrapers (above, right) like this can scoop up and evenly distribute 20 cu. yds. at one sweep. They are dependably powered by Detroit Diesel engines with sturdy ArmaSteel pistons.

Always impressive workers, diesel shovels and trucks such as these (above) provide further proof of ArmaSteel pistons' great strength and long fatigue life.

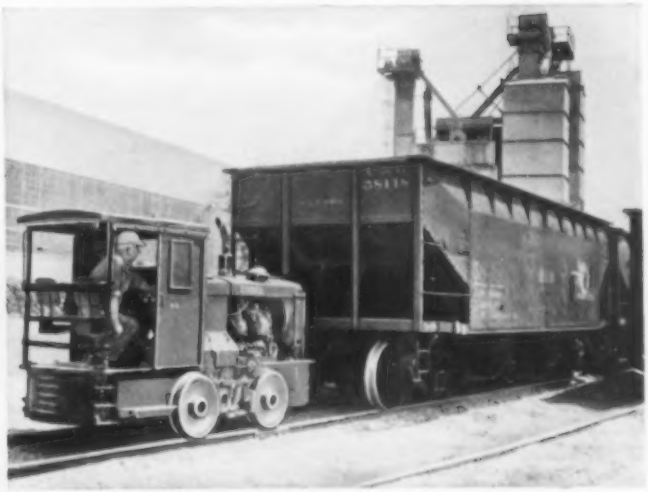
Seagoing tugs (right) with Detroit Diesel engines give ArmaSteel pistons a chance to prove their amazing fatigue life, since this application calls for an engine which is built to provide long hours of steady, unremitting service.

is proven in tough DETROIT DIESEL Engines

Fleet, smooth-powered giants of city streets and highways, these heavy busses subject their Detroit Diesel engines to violent speed changes, rapid load variations. In these applications, the ArmaSteel pistons prove that they are practically impossible to wear out (records show many busses run from 300,000 miles up to 550,000 miles without engine overhaul).



At this portable asphalt plant, where inaccessibility to utility power lines makes diesel power mandatory, a single generator, driven by a twin-6 GM Detroit Diesel engine furnishes power for 10 electric motors.



Dubbed "the Mighty Midget", this 8-ton yard locomotive—scarcely larger than a handcar—moves as many as 12 cars at once. The 3 ArmaSteel pistons in its power plant help it maintain its amazing power thru long hours of service.

ArmaSteel: a triumph of modern metallurgy, is repeatedly proving that it is far from reaching the limits of its versatility. These 2 free books, "ArmaSteel" and "Shell-castings", will help you discover how Central Foundry can serve you. Write for your copies.

CENTRAL FOUNDRY DIVISION

GENERAL MOTORS CORPORATION • SAGINAW, MICHIGAN, • DEPT. 10

78

Got a wire problem?

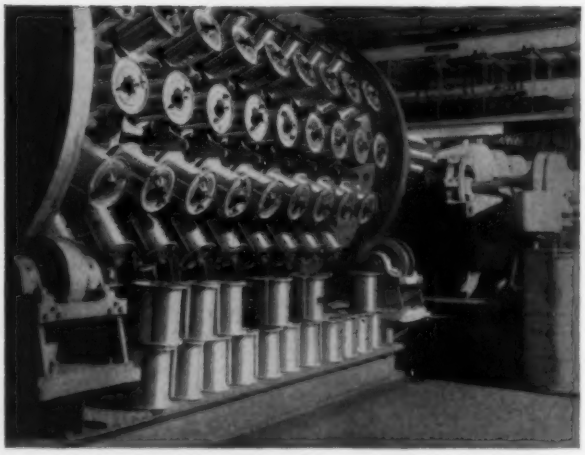
Commercial and industrial buildings must conform to an exacting set of fire and safety regulations. Glass areas are particularly troublesome because high winds and flying objects can fracture the glass and the fragments can slash a person to ribbons.

Fire can melt the glass and permit disastrous drafts that will fan a small blaze into a catastrophic fire.

For these reasons, critical glass areas must be made from wire-reinforced glass. You've seen the old-style "chicken netting" wire glass. It's durable and strong, but it hardly fits in with the sleek decor of a modern building. Mississippi Glass Company (world's largest manufacturer of rolled glass) designed a new wire reinforcement using a simple, *welded* netting wire. They asked American Steel & Wire, "Could it be made?"

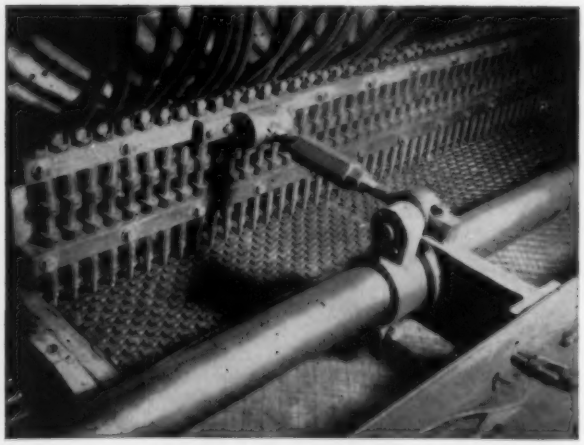
The wire had to be absolutely clean and free of dirt particles and moisture that would cause bubbles in the glass. Under these extreme cleanliness conditions, the wire had to be welded at every intersection, wire that was only .0204″ in diameter. Mississippi Glass Company designed a special machine, the only one of its kind in the world, that carries 127 spools of wire, weaves it into 66″-wide fabric, welds every joint, preserves the cleanliness and produces about two miles of netting every day.

So if *you* have a tricky wire problem, recall that American Steel & Wire knows how to do things with wire. And at the lowest possible cost. Just call your AS&W representative.

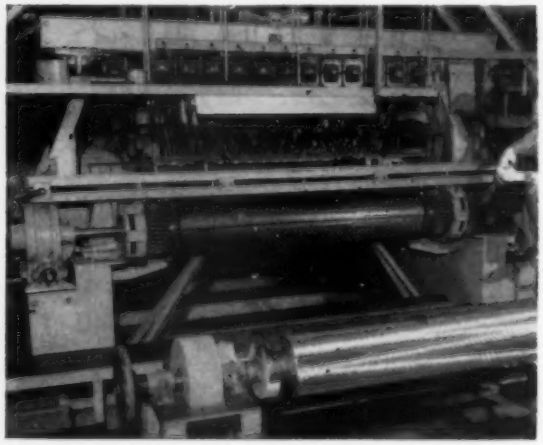


Spool end of the weaving machine. We produce a special-finish Annealed Glass Netting Wire for this use.

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL, GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY NEW YORK

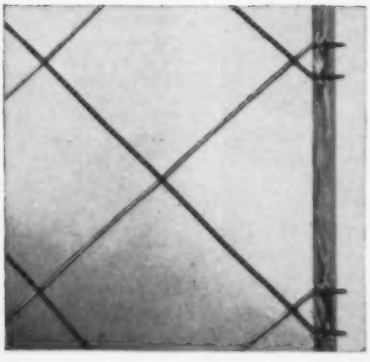


Welding the joints in the netting. This is a difficult operation, requiring very careful control.



Delivery end of netting machine. The 66″-wide rolls are made in lengths of 500 feet.

Look at this one!



This is the finished Polished Misco Wired Glass. Notice clean, simple appearance. Mesh is ¾-inch.

USS AMERICAN MANUFACTURERS WIRE

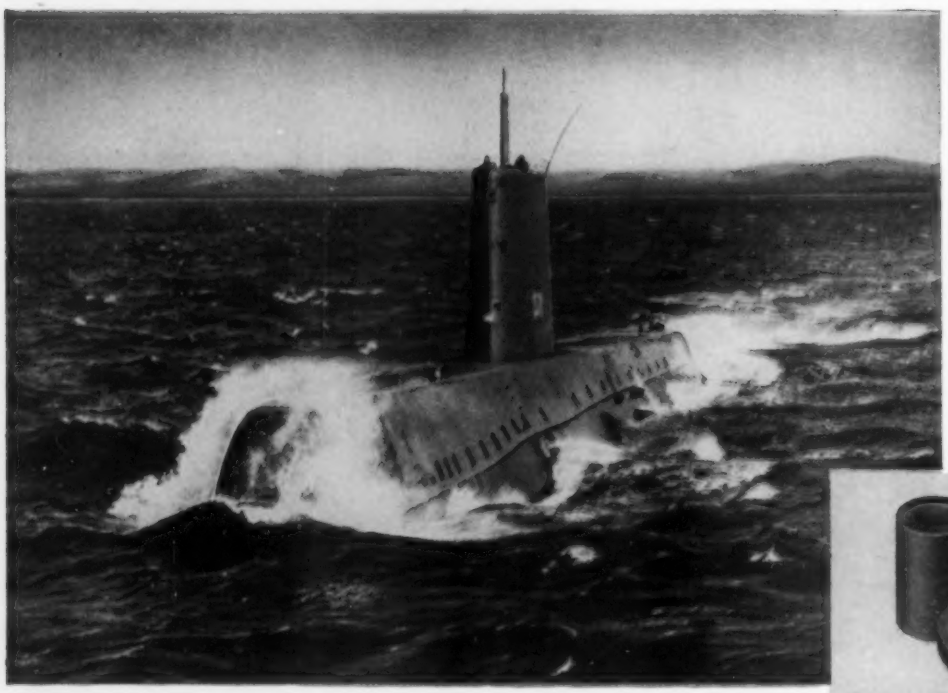
USS

AMERFINE—*high-quality fine wire.*
AMERSPRING—*music steel spring wire.*
AMERTEMP—*heavy-duty oil-tempered wire.*
AMERLOY—*alloy heading wire.*
AMERHEAD—*uniform heading wire.*
AMERSTITCH—*extra-tough metal stitching wire.*

UNITED STATES STEEL

Are your seals or bearings subject to difficult operating conditions?

GRAPHITAR® (Carbon Graphite) *has the specific properties needed in difficult applications like these . . .*

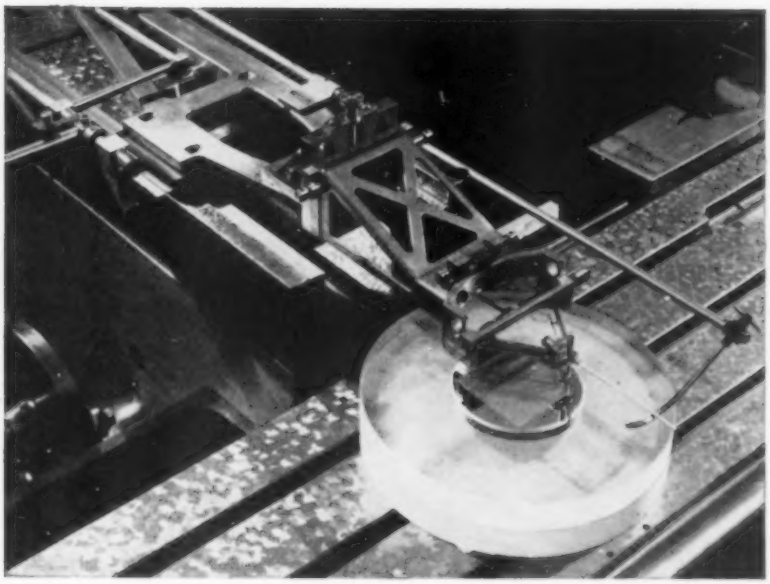


THE MOST IMPORTANT BEARING

Dependability is vital in the power plant of the Navy's atomic submarine U.S.S. Nautilus which has steamed a total of about 50,000 miles of which approximately half has been submerged. In the reactor cooling system of the submarine, special "canned" motor pumps with integrated pump and drive motor were developed by Westinghouse. The bearings in these pumps, which are made of GRAPHITAR, must withstand high speeds, high temperatures, high pressures and must operate for indefinite periods of time without maintenance and with radioactive water as the only lubricant. Westinghouse Electric Corporation engineers—the builders of the Nautilus' atomic power-plant—find that GRAPHITAR is excellent for this difficult bearing application, because of its strength, durability, self-lubricating properties, and chemical inertness. If your design calls for superior bearings, consider the material that worked on such a demanding job.

THE UNITED STATES

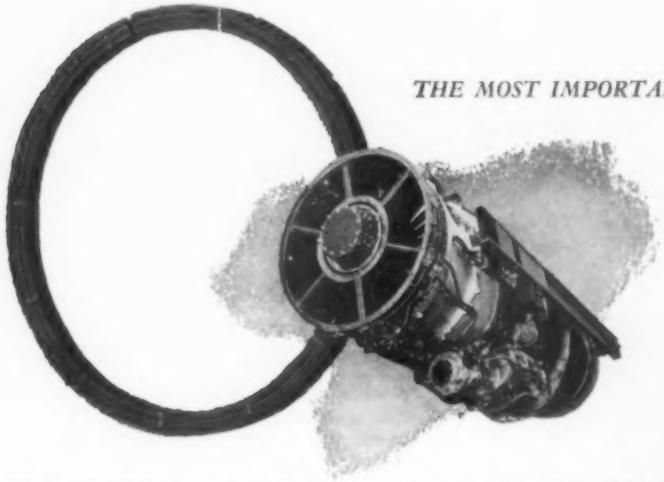
GRAPHITAR® CARBON-GRAPHITE • GRAMIX® SINTERED METAL PARTS • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES



THE MOST EXACTING BEARING

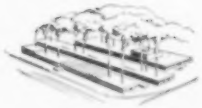
The Bausch & Lomb Optical Co. of Rochester, N.Y., world renowned manufacturer of precision, scientific optical instruments, employs 10 GRAPHITAR bearings in its unique and highly specialized "ruling engine." The GRAPHITAR bearings provide dimensional stability within one-millionth of an inch for micro-inch accuracy in cutting 15,000-30,000 equidistant lines to the inch on 7" aluminized glass blanks to make diffraction gratings used by science and industry for spectroscopic analysis. Bausch & Lomb engineers have found that GRAPHITAR is unsurpassed as a bearing material where very close tolerances must be maintained and where frequent starting and stopping under heavy loads is a problem. These bearings have contributed greatly to the achievement of extreme accuracy in this application. If you require precision performance as was the case with a "ruling engine" why not use GRAPHITAR?

THE MOST IMPORTANT SEAL



GRAPHITAR is the main shaft seal in the Pratt & Whitney J57 turbojet engine which powers many of our new aircraft, including the huge Boeing B-52 Intercontinental Bomber, which has eight of these turbojets. Naturally, the J57 must perform with utter dependability. One of the components of the J57 is the air/oil seal of GRAPHITAR on the turbine main shaft, and this seal is subjected to tremendous shaft speeds, as well as other taxing physical conditions. GRAPHITAR parts can stand severe operation because they are strong and are virtually unaffected by extremes of speed, pressure, and temperature. If your product develops high speeds or other difficult physical stresses on its parts, perhaps GRAPHITAR components could give it more dependable operation.

THE TOUGHEST APPLICATION



Steel mills are famous for the rough, tough, heavy-duty jobs that they perform. In such difficult steel mill applications as bearings for shear and cut-off tables or coil and slab conveyors, metal-backed GRAPHITAR parts provide exceptional strength and durability. GRAPHITAR alone is a very strong bearing material, and when backed with metal has added resistance to shock. Because of its very low coefficient of friction, GRAPHITAR can operate under heavy loads at high speeds with no lubrication. Can the strength and superb bearing qualities of GRAPHITAR simplify your product design?

Get your copy of Engineering Bulletin No. 20.

GRAPHITAR is compacted from carbon-graphite powders under great pressures, then furnaced at heats near 4500°F. It can be formed in relatively complex shapes and ground to tolerances as close as .0005". For more information on this strong, light, self-lubricating engineering material, write for our Engineering Bulletin No. 20.

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GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 1, MICHIGAN

A Boeing B-47 Stratojet medium bomber gets a take-off assist from 30 Phillips Petroleum Company M15 JATOs.

N-A-X HIGH-TENSILE is readily formed and welded. Here, before welding, a worker sizes the container's aft head, drawn by a 250-ton press. Bottom forging is locked in.

N-A-X HIGH-TENSILE STEEL FORMS AND WELDS READILY

Formability: Even at the higher strength levels (50% greater than mild carbon steel) this material can be cold formed and drawn into very difficult stampings and cold formed shapes.

Weldability: Its weldability by any process is excellent, maintaining toughness through a wide range of temperatures. Under-bead cracking tests are excellent. Using American Welding Society standard bead-weld testing, shows under-bead hardness rises only to 95 Rockwell from 80-85 Rockwell prior to welding.

Make *your* product better, too—
with this high-strength steel

How N-A-X® HIGH-TENSILE STEEL

supplied the money-saving answer to a critical take-off problem

JATO rockets boost heavily laden planes into the air faster, let them operate from shorter runways. A new JATO developed by Phillips Petroleum Company required a case that would endure a pressure of 1,000 pounds per square inch at the high blast temperatures. Yet it must be lightweight, easily fabricated, economical.

In 1954, 100 JATO cases of N-A-X HIGH-TENSILE steel were tested at Air Force Plant 66 near McGregor, Texas, where Phillips Petroleum is contractor-operator.

Result: The N-A-X HIGH-TENSILE case passed every test with flying colors. It *surpassed* the required standards for strength by as much as 20 percent.

The high-strength characteristics that make N-A-X HIGH-TENSILE a better steel for JATO fuel containers also make it better for many other types of pressure containers, where high strength and lighter weight are equally important. It is particularly suitable for Propane cylinders and pressure vessels for the chemical, automotive and oil industries, that must withstand severe interior pressures and handling abuses . . . and for such products as truck and trailer frames, wheels and bumpers, railroad and earth-moving equipment, shipping containers, pipe, and many others.

Other Important Advantages: N-A-X HIGH-TENSILE STEEL, compared with carbon steel, is 50% stronger • has high fatigue life with great toughness • is more stable against aging • is more resistant to atmospheric corrosion. It polishes to a high luster at minimum cost • has greater resistance to abrasion or wear • offers greater paint adhesion.

With N-A-X HIGH-TENSILE you can design longer life, strength with lightness, and economy into your products. Let us show you how.

COMPANION HIGH-STRENGTH STEEL IN THE N-A-X FAMILY

N-A-X FINEGRAIN. A low-alloy high-strength steel ideally suited for applications where the enhanced resistance to atmospheric corrosion of N-A-X HIGH-TENSILE is not required.

N·A·X
HIGH-TENSILE STEEL

N-A-X Alloy Division
GREAT LAKES STEEL CORPORATION
Detroit 29, Michigan — Division of
NATIONAL STEEL CORPORATION

N-A-X Alloy Div., Dept. C
Great Lakes Steel Corp., Detroit 29, Mich.

☐ Please send me 8-page illustrated technical catalog on N-A-X HIGH-TENSILE Steel.

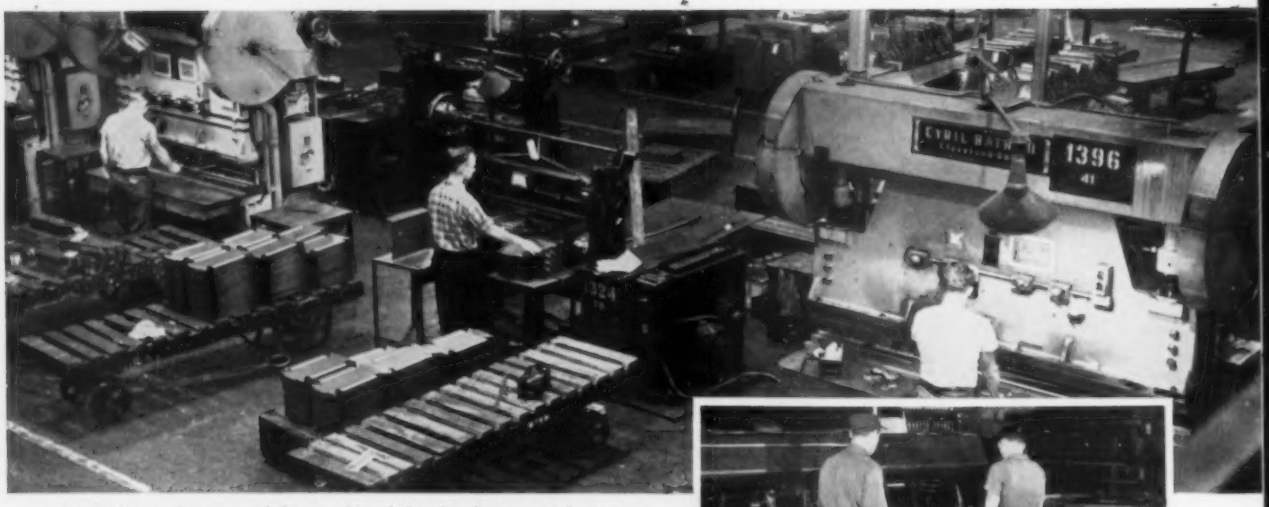
☐ Please have your representative contact me.

Name_____ Title_____

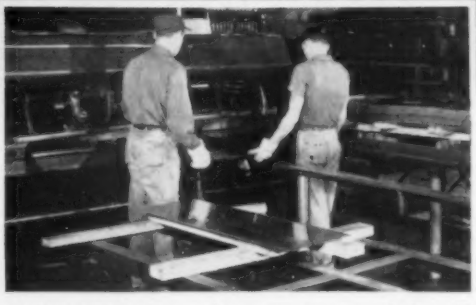
Company_____

Street_____

City_____ Zone_____ State_____



1 PUNCHING— Presses used for punching holes, knockouts, and for stamping small parts are strategically located for efficiency. Some of them run at the rate of 108 strokes a minute, with capacities up to 250 tons. Equipment like this means high-speed production of big-volume runs at low unit cost.



2 SHEARING— Berger shears operate at speeds from 40 to 60 strokes a minute. They can cut sheet steel up to 14' on the shortest dimension . . . handle medium-hard stock up to ⅜" thick. Berger designers and craftsmen know how to use this equipment to give you the most for your money.

PLANNING OR FABRICATING A SHEET STEEL PRODUCT?

...Republic can take the

You may not realize how many different products are made in Republic's Berger Division plants because many are fabricated for other manufacturers and marketed under their brand names. We will manufacture *your* product in volume runs—engineer, fabricate, finish, pack and ship, all to *your* specifications.

Some of our contract-fabricated products are completely assembled units with operating mechanisms installed. Others are sheet metal assemblies that leave our plants finished with a prime coat, ready for final finishing, assembly and packing by our customer.

Our large stock of standard tools and dies and the specialized equipment of our Berger Plants are available to you. Often we can reduce costly tooling investments because we already have the tools to do the job. Because you use our facilities, you can eliminate the overhead problems of building or expanding your plant.

Constant research and development at Berger have resulted in advanced processes and equipment to make your fabricated sheet steel products more attractive, and more economical. Furthermore, our facilities and fabricating experience provide you with the same high quality you see in our own products—lockers, office furniture, shelving and steel kitchens.

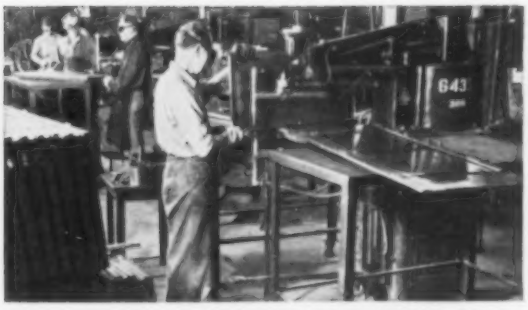
If you have a sketch or blueprint, send it along to us with complete specifications. We'll tell you promptly what Berger's specialized service can do for you. Learn more details in Bulletins 793 and 908.

REPUBLIC

REPUBLIC STEEL

World's Widest Range of Standard Steels

3 FORMING—Brakes run at speeds as high as a stroke a second, and range in capacity from 60 to 500 tons. This means that Berger can handle a variety of production, and various gages, simultaneously. Your product keeps moving.



4 WELDING—Berger's major plant facilities include the very latest welding equipment and techniques. Eighty-eight welders are strategically located to do the best job . . . and do it most economically. When Berger takes your contract, your products keep rolling.

5 BONDERIZING—We're proud of our finishing facilities. And, our new Bonderizing equipment makes them better than ever. As it passes along our Bonderizing line, your product is given exceptional ability to take and hold a fine painted finish—and it acquires superior rust-resistance.

6 ELECTROSTATIC SAFEGUARD—Another reason why Berger-applied finishes are unexcelled. Not one speck of dust can penetrate this electrostatic screen to settle on your product. Electrostatic recovery of atomized paint means greater economy, too.

whole job off your hands

7 PAINTING—We're equipped to paint over 87,000 square feet of steel surface each hour! Equipment includes degreasers for cleaning mill stock parts, mechanical Bonderizers, electrostatic safeguards, 32 spray booths and six dip tanks. Plus 40 baking ovens to assure beautiful, lasting, baked-on finishes that match your sample for color.

8 PACKING AND SHIPPING—The product above is being shipped knocked-down, in cartons. More Berger packing equipment includes newest machines for crate-making and automatic nailing. Beyond our doors, more advantages—you are shipping from centrally-located Canton, Ohio. From planning to packaging, Berger can take the whole job off your hands.

STEEL

and Steel Products

REPUBLIC STEEL • BERGER DIVISION
Dept. C-4002
1046 Belden Avenue, Canton 5, Ohio

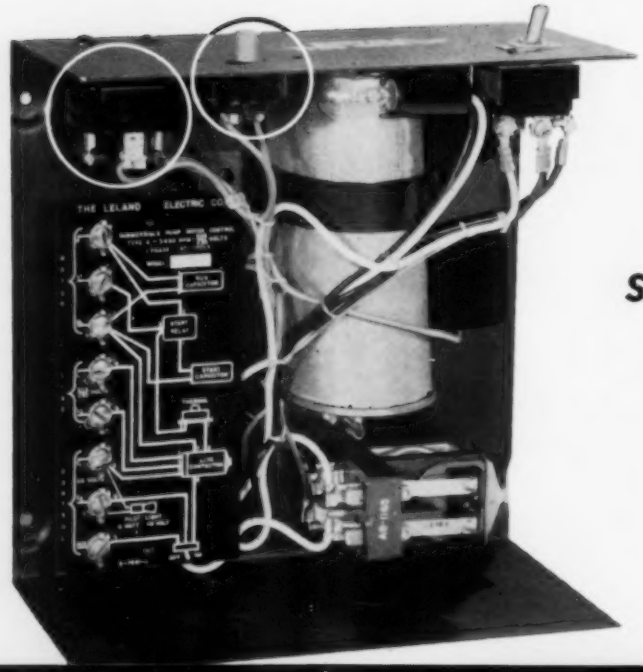
Please send Bulletins 793 and 908 describing Berger fabricating facilities and abilities.

Name _____ Title _____

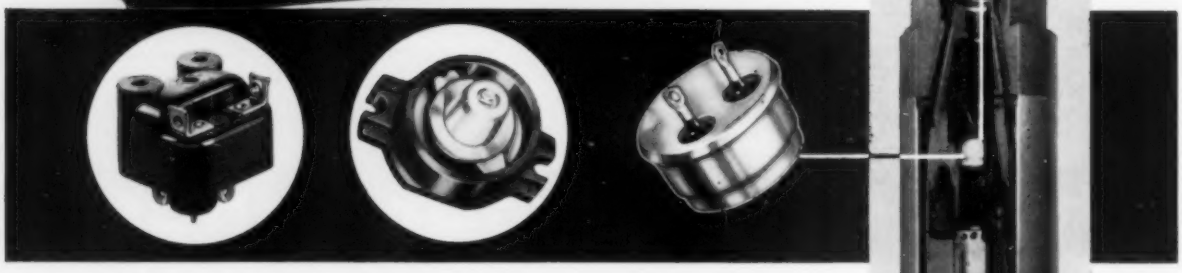
Firm _____

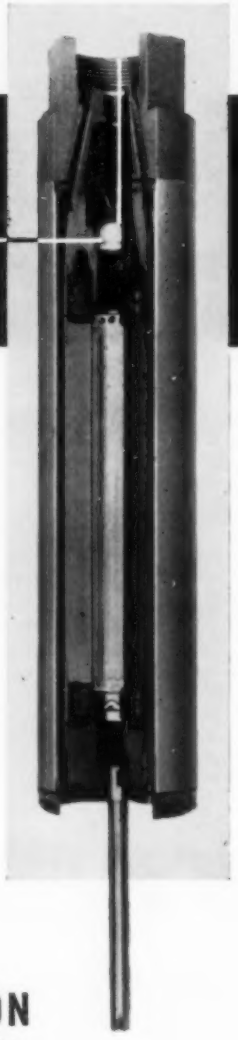
Address _____

City _____ Zone ____ State _____



LELAND
Pump Motor
Operates Submerged in Gasoline—
Motor Protection by
KLIXON
PROTECTORS





In over 30 years the Leland Electric Company has been a leader in supplying explosion-proof motors for gasoline service station pumps.

Recently, Leland announced its development of its submersible explosion-proof pump motor which can serve from 4 to 8 pedestals. As Leland says, *"When a motor operates submerged in gasoline, overload protection is of greatest importance. Therefore, Leland, as always, depends on KLIXON Protectors."*

Here's how Mr. E. C. Briggs of Leland describes the new pump and the function of the KLIXON Protectors:

"The development of the submersible gasoline pump motor required that careful consideration be given to adequate safety precautions. The motor design is explosion-proof and all Underwriters' requirements have been met. Added safety is obtained by the use of two KLIXON Protectors made by the Spencer Thermostat Company. One of these units is a hermetically sealed protector embedded in the motor end frame to give running motor protection, as might be necessary in the case of a rubbing impeller in the pump or a low gasoline level in the tank.

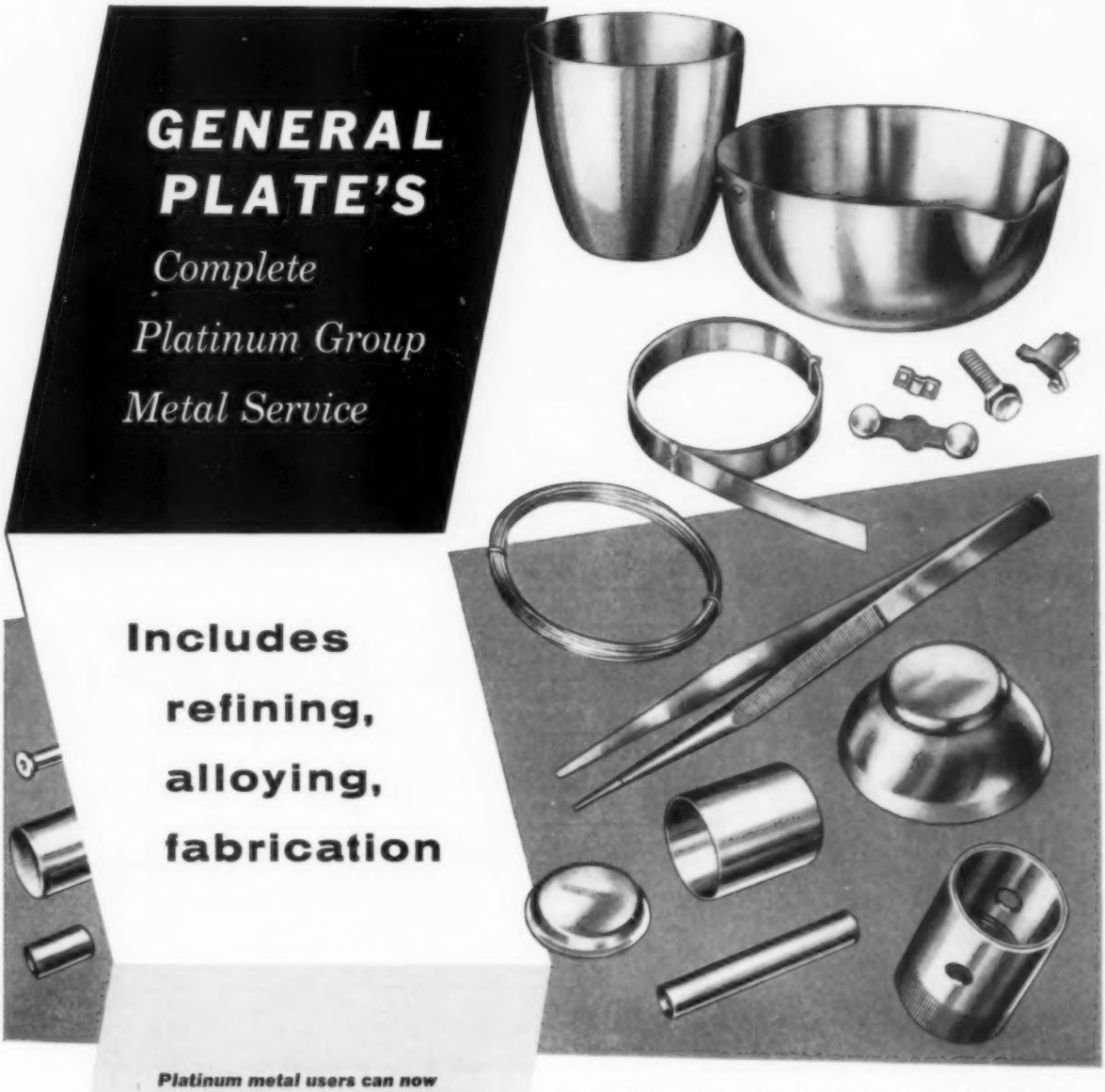
"Another added protection feature is the use of a manual reset type KLIXON Protector located on the control box which would protect the motor from a jammed impeller or other stalled torque conditions."

You, too, can keep motors in your equipment operating at maximum safe capacity, can reduce service calls and repairs by specifying and using KLIXON Protectors. The additional cost is low . . . the additional benefits extremely worth while.

METALS & CONTROLS CORPORATION
Spencer Thermostat Division
3806 Forest Street, Attleboro, Mass.
KLIXON

GENERAL PLATE'S

Complete Platinum Group Metal Service



Includes refining, alloying, fabrication

Platinum metal users can now take advantage of General Plate's expanded facilities—one of the most modern and complete in the industry.

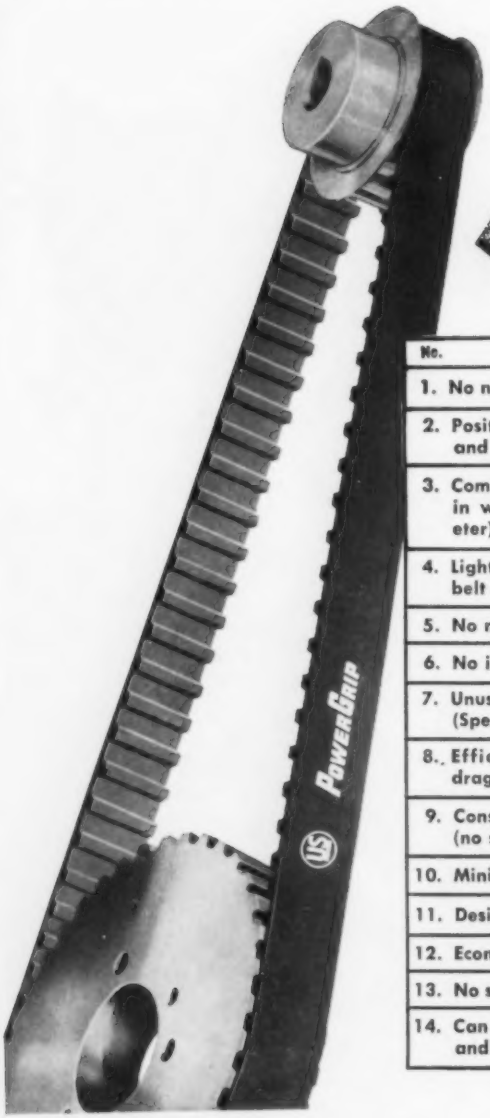
Get full information now... write for free catalog, PR-800, which details platinum laboratory ware. No obligation.

Here's how General Plate can serve you in platinum group metals. We are in a position to:

- ✔ Assay and refine platinum group metals.
- ✔ Recover and rework your scrap materials.
- ✔ Supply platinum group metal alloys.
- ✔ Produce electroplating solutions and chemical compounds for catalysts.
- ✔ Produce solid and composite platinum group metals in sheet — foil — wire — tubing — gauze.
- ✔ Fabricate electrical contacts and contact assemblies for magnetos, instruments and controls; produce laboratory ware, linings for vessels, thermocouple wire, and other parts — all to exacting customer's specifications.

METALS & CONTROLS CORPORATION

General Plate Division 1006 Forest Street, Attleboro, Mass.



"√" in your transmission belt needs

No. Advantages	PowerGrip "Timing" Belt	Chain	Gear	V-Belts	Flat Belts
1. No need for lubrication	√				
2. Positive elimination of slip and creep	√				
3. Completely compact (Both in width and pulley diameter)	√				
4. Lightweight (Heavy duty belt only 0.1 lb./ft./in.)	√				
5. No noise or vibration	√				
6. No initial tension	√				
7. Unusual speed range (Speeds up to 12,000 FPM)	√				
8. Efficient (Elim. heat, lube drag, high bearing loads)	√				
9. Constant angular velocity (no speed fluctuation)	√				
10. Minimum backlash	√				
11. Design flexibility	√				
12. Economical	√				
13. No stretch	√				
14. Can it be completely housed and forgotten?	√				

Note that the U. S. PowerGrip "Timing" Belt takes a "√" after every advantage

While every type of drive has certain advantages, *no* type of power transmission possesses *so many* advantages as the U.S. PowerGrip "Timing" Belt drive. For example, *it is the only positive drive that never needs lubrication.*

THE LIST OF USES GROWS DAY BY DAY! Power production machinery in every field is made more efficient, volume of production increased, and maintenance costs lowered with this amazing belt. The list of OEM applications grows too numerous to mention. U.S. PowerGrip has streamlined hundreds of products... made them sell above competition. Some equipment would not be in existence at all, if it weren't for this great belt.

U. S. PowerGrip "Timing" Belt drives—from fleapower to 1000 h.p., and with ratios up to 12 to 1—are obtainable at any of the 28 "U. S." District Sales Offices, at selected "U. S." distributors, or by contacting us at Rockefeller Center, New York 20, New York. In Canada, Dominion Rubber Co., Ltd.

Send for free illustrated manual, complete with standard drive tables.

US RUBBER

Mechanical Goods Division

United States Rubber

Drafting Department Heads!

Faced by growing demands of the production boom... the shortage of experienced personnel?

Look how Bruning can help you add

to your Drafting Room!

Look How Many Ways New, Modern Bruning Products Add Manpower to Your Drafting Room by Saving Man Hours of Work!

SAVE
DRAFTING
MAN HOURS

SAVE
REPRODUCTION
MAN HOURS

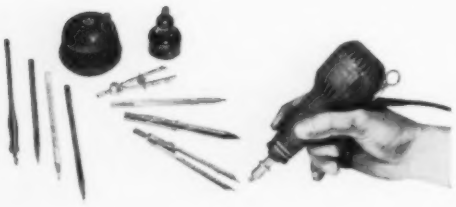
SAVE
FILING
MAN HOURS

Right now when you need it... add manpower to your drafting room by replacing old or inadequate equipment and materials with these modern, time-saving Bruning Products!

At the *drawing board*, at the *reproduction machine*, at the *files* . . . you can add manpower right now by helping your personnel turn out more work, faster and easier, with these modern, higher-production Bruning products.

See how modern Bruning drafters speed drafting up to 40% on most jobs . . . new and better tracing papers and cloths enable faster drawing and reproduction . . . improved intermediates slash re-drafting time for design changes . . . new, improved Copyflex machines provide faster and more convenient reproduction.

In the face of growing demands of the production boom and the shortage of experienced personnel, you couldn't choose a better time to replace old or inadequate equipment with these new, higher-production products you've been wanting. You couldn't pick a more opportune time to get management approval for new equipment expenditures.



Bruning's wide selection of drafting aids includes not only standard items, but many special time-and-work savers such as dotting pens, proportional dividers, planimeters, special purpose templates, and Bruning electric erasing machines that save hours of finger-cramping manual erasing.

MODERN DRAFTING TOOLS AND SUPPLIES HELP SPEED DRAFTING

BRUNING

MODERN BRUNING TRACING MEDIUMS SPEED DRAWING AND REPRODUCTION

These new, improved drawing mediums are unsurpassed for translucency, pencil-and-ink taking qualities, workability, permanence. You'll draw easier and faster; get cleaner, sharper prints, in record time.

Just Out! New "Visi-Vel" resin-transparentized tracing paper offers up to 25% faster reproduction speed!

MODERN HAMILTON DRAFTING TABLES REDUCE WASTE MOTION AND FATIGUE

Unique design of Hamilton Auto-Shift lets draftsman work on any part of the board, reach reference table and drawers without leaving his seat. And you can put six Auto-Shift tables where you now have four boards with separate reference desks.

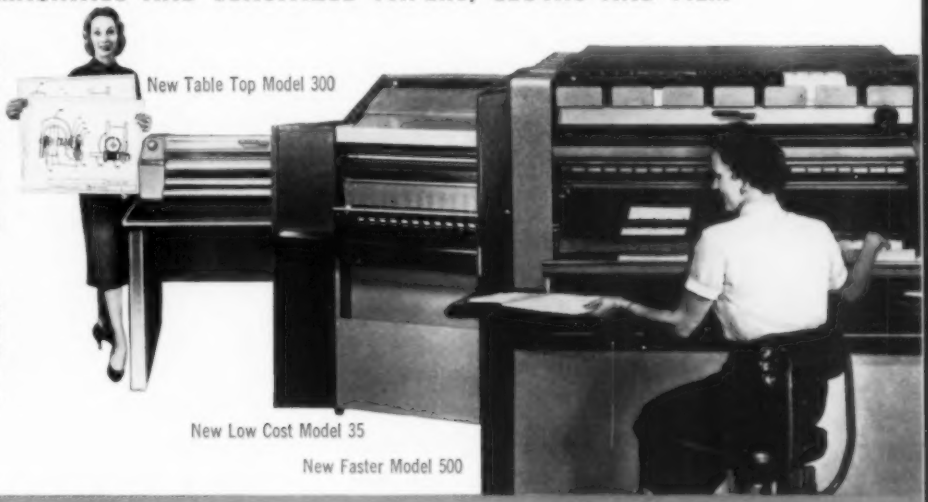
MODERN BRUNING DRAFTERS SPEED DRAFTING UP TO 40%

Over conventional equipment, Bruning drafters speed drafting up to 40% on most jobs . . . up to 50% on some structural drawings. Patented "Equipoise" gravity compensator, exclusive touch control indexing provide unrivalled simplicity, precision, and ease of operation. Counterbalanced and Track Drafters slash man hours of work on large drawings. Standard or Civil Engineer protractor heads.

MODERN COPYFLEX MACHINES AND SENSITIZED PAPERS, CLOTHS AND FILM

Speed Reproduction! New, advanced Copyflex models bring you faster reproduction speed and a host of operator conveniences such as fast return of originals, automatic separation, front or rear delivery. And all the benefits of diazo black-on-white reproduction, plus problem-free operation and installation. No fumes, no exhaust ducts. There's a Copyflex model to meet every need and budget. New, better Copyflex sensitized materials work together with Copyflex machines to speed reproduction, give you premium results.

Slash Re-Drafting Time! Save up to 90% tracing time by making modern Copyflex intermediates (translucent prints) of drawings to be re-worked. Mask out unwanted portions before reproducing the intermediate, add new lines or sharpen up weak lines on the intermediate itself, produce sharp, clear prints from the intermediate.



New Table Top Model 300

New Low Cost Model 35

New Faster Model 500

HAMILTON WOOD FILING UNITS

Combine exactly the interchangeable units you need—in higher stacks—to save time and space. Sturdy oak construction.

PLAN HOLD FILING EQUIPMENT

Save time, space, and damage in filing large active plans. Spring-loaded, clamp-style binders eliminate punching, stapling, bolting or folding of plans. Binders are easily mounted in wall racks, floor stands, cabinets. A binder holds up to 150 plans.

MODERN HAMILTON ALL-STEEL UNITSYSTEM FILES SAVE TIME, SPACE; PERMIT ORDERLY EXPANSION

You file drawings and records in units especially designed for them by size and frequency of use. Drawings are easier to file and find, which saves time. UnitSystem's interlocking feature lets you combine exactly the units you need—in higher stacks—which saves space. It lets you expand your filing set-up gradually, efficiently, and economically.

GIVES YOU MORE TO HELP SAVE MAN HOURS . . . ADD MANPOWER TO YOUR DRAFTING ROOM . . .

3 more reasons why you can depend on Bruning to help you

Save Man Hours...Add Manpower to Your Drafting Room!

Researcher, manufacturer, and supplier . . . Bruning saves you many man hours by providing a single, convenient, dependable source for everything you need in top-quality drafting room supplies and service. You simplify ordering and stocking, save time and money. You get the following important benefits!

New and Better Products— from Bruning Research and Engineering

Bruning Research and Engineering has introduced such great time-and-work savers as the first pencil tracing cloths, the first fume-free whiteprinters in America, the first band-type drafting machines. Today, by virtue of its modern laboratories and large engineering staffs, Bruning still leads the way. In just the last two years, Bruning has introduced five new, advanced reproduction machines, many newly improved tracing materials. You can count on more new and better products coming to help you save man hours, add manpower.

Consistently High Quality —from Bruning Manufacturing

In its own modern paper converting plants at Teterboro, N.J., Chicago, Kansas City, Los Angeles, and Toronto, Ontario, Bruning controls quality all the way to bring you tracing mediums and sensitized materials of dependable, consistent high quality. The famous Copyflex reproduction machines are entirely Bruning manufactured to provide you the finest in reproduction performance.
You get better results, minimize the risk of trouble and loss of man hours.

▲ 36 Bruning Sales-Service Branches
● 6 Bruning Distributors
◬ 5 Strategically Located Plants

The Product and Help You Need When You Need Them—from Bruning Sales Service

You suffer no costly delays—no loss of man hours—for lack of supply or service. With the most comprehensive network of sales-service branches, distributors, and plants in its field, Bruning assures you of prompt, dependable service and supply.

Your nearby Bruning branch is headquarters for a capable staff of Bruning sales-service specialists who are immediately available to you. Your nearby Bruning branch or distributor carries a full line of Bruning products and is staffed and equipped to give you fast, efficient supply.

Right now is the time to capitalize on Bruning's great time-and-work saving products and Bruning's outstanding service and supply. They work together to help you save man hours—add manpower to your drafting room, now when you need it!

BRUNING

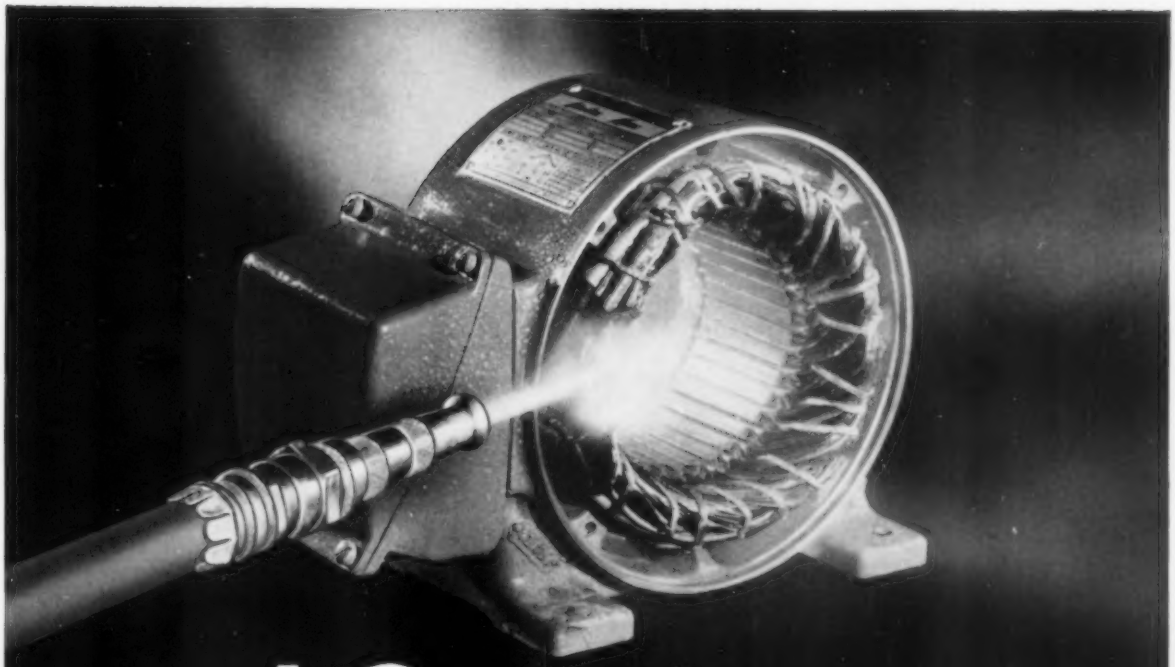
America's Leading Supplier of Engineering and Drafting Equipment

CHARLES BRUNING COMPANY, INC., 4700 MONTROSE AVE., CHICAGO 41, ILLINOIS

In Canada: Charles Bruning Co. (Canada), Ltd., 105 Church Street, Toronto 1, Ontario

A-2320

Printed in U.S.A.



10 REASONS

WHY WESTINGHOUSE *BONDITE* VARNISH IS SUPERIOR TO ALL OTHER CONVENTIONAL TYPES...

for all Class "A" and "B" Applications

1. **BONDITE** is *saturated throughout* with silicone, upgrading the excellent properties of the other resins in the varnish.
2. **BONDITE** not only repels *surface-moisture* — its resistance is effective *throughout the cured mass!*
3. **BONDITE** retains its high dielectric strength at high temperatures in continuous service.
4. **BONDITE** meets MIL-V-1137 A specification, Type M, Grade CB.
5. **BONDITE** is fully thermosetting, providing excellent through cure.
6. **BONDITE** uses *low toxicity* naphtha as the thinner.
7. **BONDITE** offers *superior oil resistance* for dry type *and* oil immersed transformers.
8. **BONDITE** ASTM Flex Life or Heat Endurance, is nearly *double* the life of most conventional varnishes.
9. **BONDITE** is a product of Westinghouse Research — with an outstanding record of proven performance.
10. **BONDITE** has flexibility in application . . . it's available in consistencies for either dipping or impregnation.

J-09654

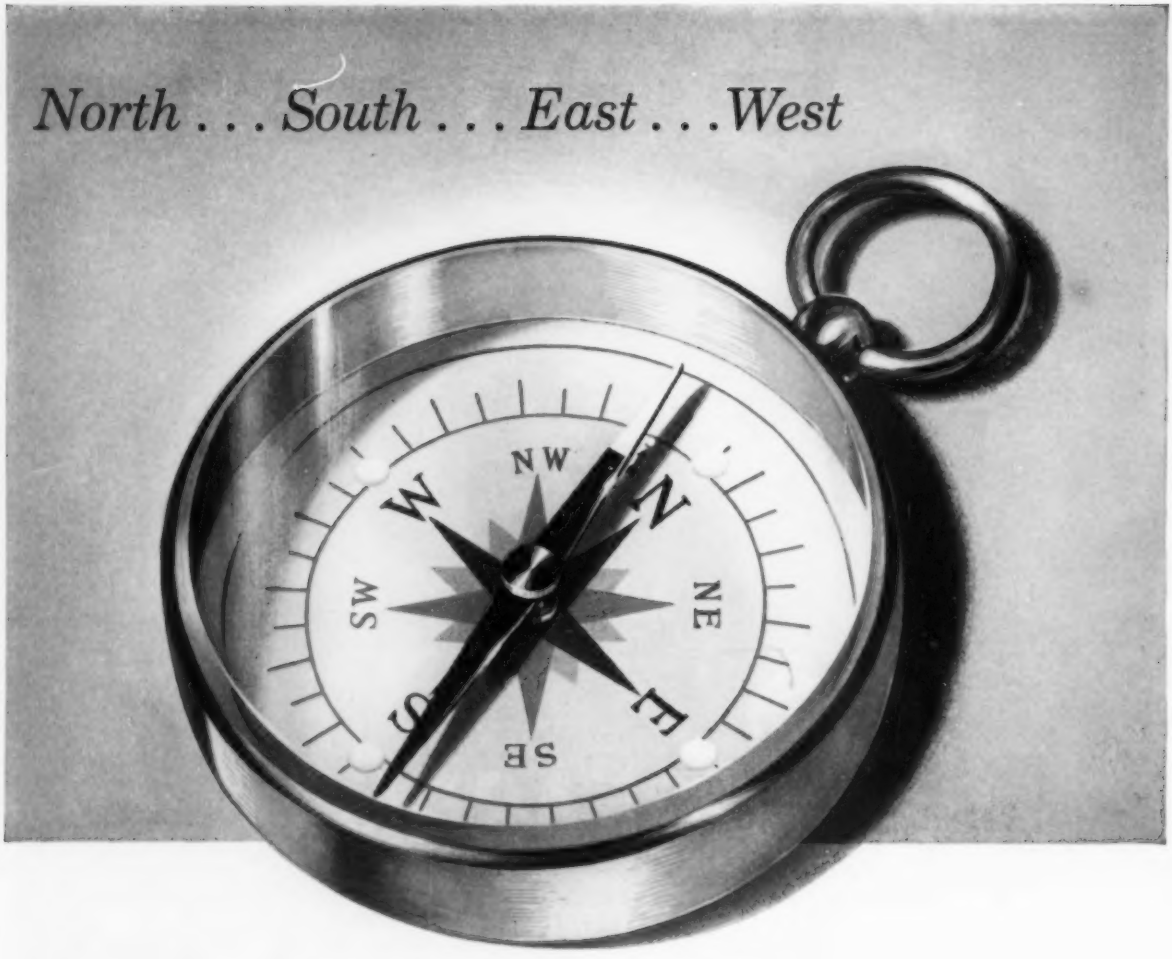
YOU CAN BE SURE...IF IT'S

Westinghouse

WESTINGHOUSE ELECTRIC CORPORATION
Benolite Plant • Manor, Pennsylvania

Please send me your Complete Line Catalog on Westinghouse Benolite varnishes, enamels, finishes and varnished insulations. (B-7206) PE-6-57

Name _____
Title _____
Company _____
Address _____
City _____ State _____



The performance and the name are the same around the world

MACHINERY MANUFACTURERS:

The performance of Shell Alvania Grease enjoyed by your domestic customers is available abroad. And this same uniformity applies to

SHELL TURBO OIL—gives anti-wear lubrication for utility, industrial and marine turbines

SHELL TELLUS OIL—lubricant and control fluid for complex hydraulic systems, and a complete line of other

SHELL INDUSTRIAL LUBRICANTS

Shell Alvania Grease, used world-wide as a multi-purpose lubricant, has an outstanding performance record in solving many of the toughest anti-friction bearing grease problems. Ideal for wet, humid applications (inhibited to prevent water corrosion), it lubricates under water-wet conditions which normally spell trouble.

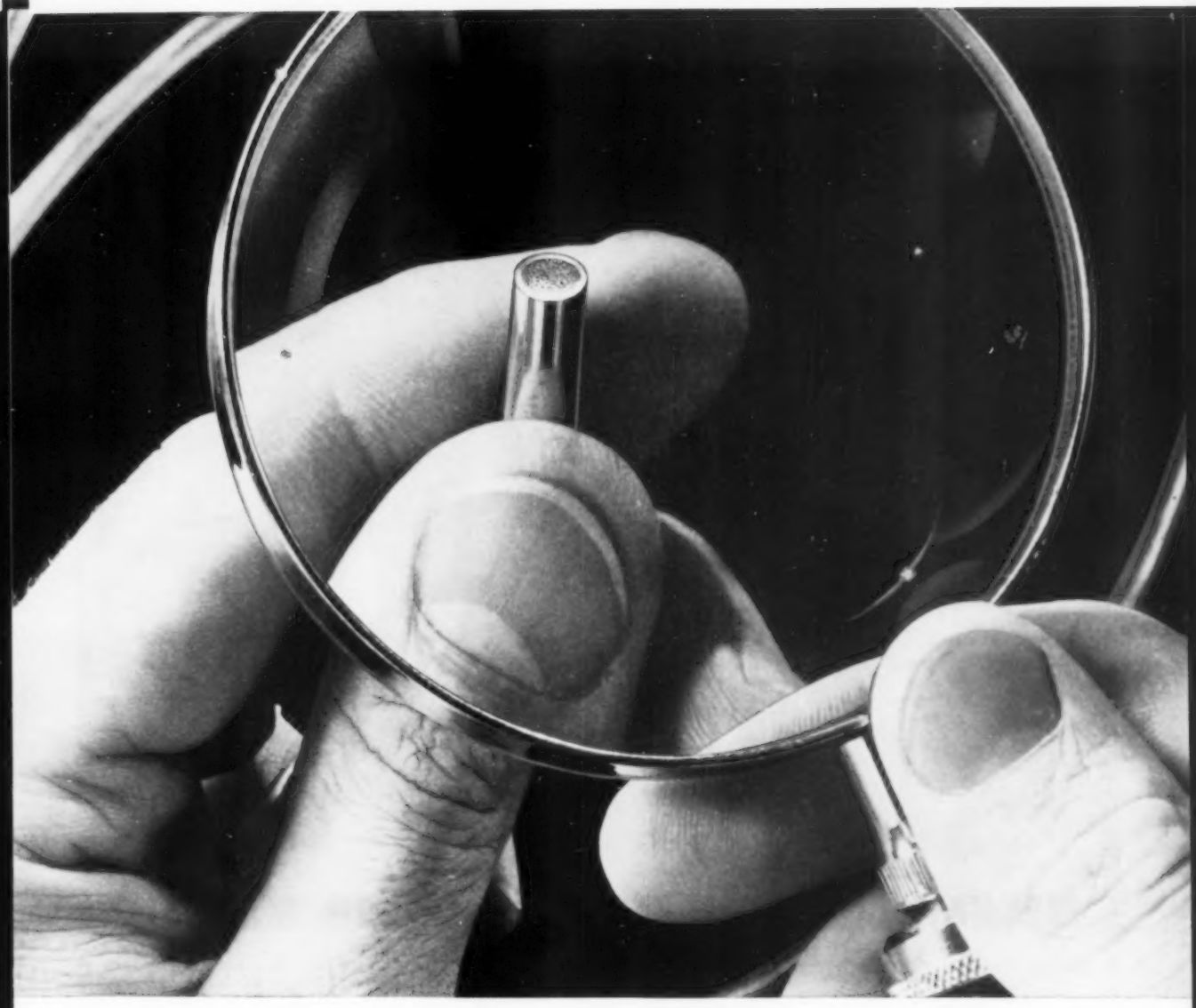
Alvania* Grease has the added advantage of remaining plastic in sub-zero weather and stable under sustaining high temperatures. This one grease successfully replaces dozens of special lubricants in plant after plant . . . reason enough for its universal popularity. For complete information, write Shell Oil Company, 50 West 50th St., New York 20, N. Y., or 100 Bush St., San Francisco 6, Calif.

*Trademark

SHELL ALVANIA GREASE

A TRULY MULTI-PURPOSE LUBRICANT

SHELL



UNIQUE COPPERPLY® WIRE . . . *unique advantages!*

• National-Standard Copperply is unique because its heavy copper jacket is bonded to a steel wire core by a continuous *electroplating* process. This results in precise concentricity and permits closely controlled coating thickness. It also permits the use of core steels in a wide range of analyses.

The coating is so uniform and the bond so permanent that Copperply can be twisted, bent, flattened, stranded, woven or even roll-threaded without the slightest danger of rupturing the coating or otherwise exposing the core. Thus Copperply's extreme uniformity and permanence mean prolonged service life and maximum protection against rust, regardless of forming or service requirements.

The uses for this unique new wire are many. They range from high strength communications line and electronic applications to wire for non-rust masonry ties and decorative jewelry chain—*wherever* the combined qualities of copper and steel can work to advantage.

Name the use you have in mind and let National-Standard help you work out details. It's part of our unusual service.

NATIONAL NS NATIONAL-STANDARD Company **STANDARD**

DIVISIONS: NATIONAL-STANDARD, Niles, Mich.; *tire wire, stainless, music spring and plated wires* • WORCESTER WIRE WORKS, Worcester, Mass.; *high and low carbon specialty wires* WAGNER LITHO MACHINERY, Secaucus, N. J.; *metal decorating equipment* • ATHENIA STEEL, Clifton, N. J.; *flat, high carbon spring steels* • REYNOLDS WIRE, Dixon, Ill.; *industrial wire cloth*

MECHANICAL MONSTER OR MODERN MARVEL?

Select the P&B Relay which helps make the difference

AG Series
Enclosed Power Relay
Shock-Proof and Dust Proof

MW Series
Appliance Type Relay
with above Average
Performance and Life.

AB Series
Appliance Type Relay,
Heavy Duty Construction.

Proper controls turn monsters into marvels . . . and controls are only as good as their components, such as relays. Without controls, this massive press, or any automated equipment, becomes a nightmare of disorganized force.

P&B AG Series relays are particularly suited to automation. They are ruggedly constructed for excellent shock resistance, withstanding 100 G shock without mechanical damage. The AG is a tough relay designed for rough jobs.

A metal enclosure keeps out shop dust and dirt. The phenolic base meets all U/L requirements for spacing and creepage distances . . . and the DPDT contact arrangement permits a wide variety of circuit variations.

For over 25 years, P&B has been building relays, and modifying existing types, to suit specific applications. Write for new catalog or engineering consultation.

ENGINEERING DATA

SERIES: AG. Enclosed power relay for use in dusty or dirty applications.

CONTACTS: 3/16" dia. fine silver. Rated 5 amps., single break, 115 V. AC resistive. Rated 8 amps., double break, 115 V. AC resistive.

CONTACT ARRANGEMENTS: SPST NO-DM, SPST NC-DB, DPST-NO, DPST-NC, DPDT.

VOLTAGE RANGE: DC: 6 to 220 V. AC: 6 to 230 V.

COIL RESISTANCE: 30,000 ohm maximum.

POWER REQUIRED: 1.5 W. minimum DC at 25° ambient. 6 W. maximum.

AMBIENT TEMP. RANGE: —55° C. to +85° C.

TERMINALS: Screw type molded in phenolic base.

ENCLOSURE: Special dust cover.

DIMENSIONS: 2¾" L x 2 11/32" W. x 3 5/32" H.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC, ELECTRICAL AND REFRIGERATION DISTRIBUTORS

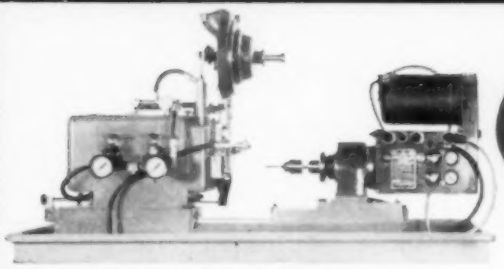
Potter & Brumfield, inc. PRINCETON, INDIANA

Subsidiary of AMERICAN MACHINE & FOUNDRY COMPANY

See our catalog in Sweet's Product Design File.

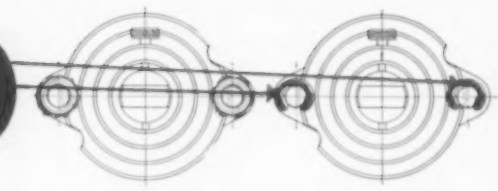
Manufacturing Divisions also in Franklin, Ky. and Laconia, N.H.

Waldes Truarc Retaining Rings Eliminate Machining and Parts—Cut Assembly Time on Drill and Tapper



Beco Model 410 Drill and Tapper

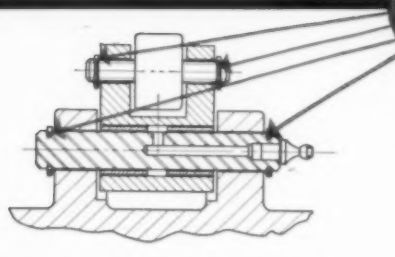
The Batchelder Engineering Co., Inc., Springfield, Vermont uses 4 different sizes of 2 different type Waldes Truarc rings in their new BECO Model 410 Automatic Drill and Tapper. Truarc rings speed assembly, reduce machining, improve design.



ALTERNATE DESIGN TRUARC DESIGN

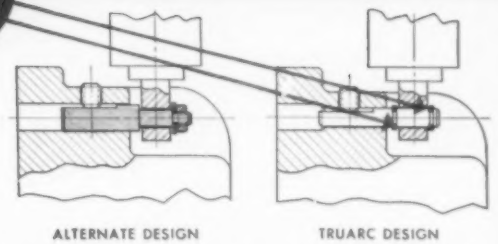
Clamp Cylinder Rod Stop Assembly

Truarc "E" Rings (Series 5133) replace stop nuts in the Clamp Cylinder assembly. They eliminate need for threading 2 rods ...the danger of cross-threading nuts...and costly rejects. Truarc Rings cut assembly time and cost.



Bell Crank Pivot Assembly

Truarc Rings (Series 5100) in Bell Crank Pivot assembly permit grease hole not possible with cotter pin fastener. Use of nuts would have increased machining and assembly costs considerably.



ALTERNATE DESIGN TRUARC DESIGN

Hopper Cylinder Anchor Pin Assembly

2 Truarc Rings (Series 5100) secure and position end of vertical air cylinder. Rings eliminate extra cost of machining 3-diameter pin, threading and undercutting...plus nut and washer. Assembly is quick and sure.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product...to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types...as many as 97 different sizes within a type...5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today...let our Truarc engineers help you solve design, assembly and production problems...without obligation.

For precision internal grooving and undercutting...Waldes Truarc Grooving Tool!

WALDES

TRUARC®

RETAINING RINGS

WALDES KOHINOOR, INC.
47-16 AUSTEL PLACE, L. I. C. 1, N. Y.

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N.Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

Name _____

Title _____

Company _____

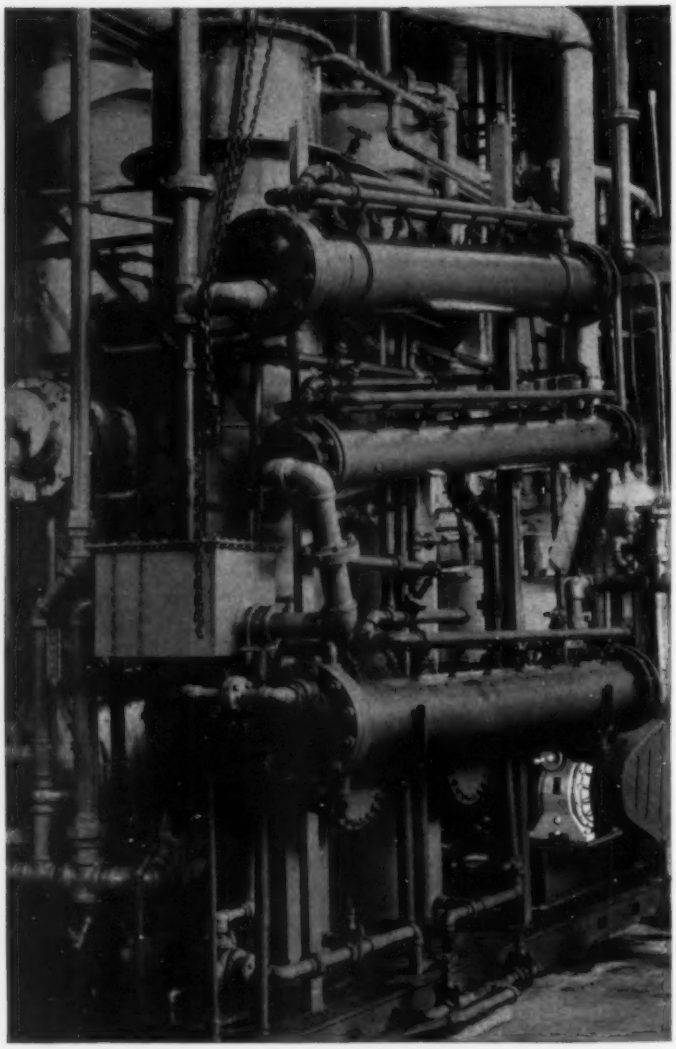
Business Address _____

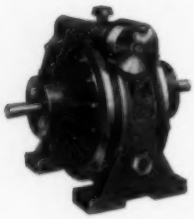
City _____ *Zone* *State* _____

PN069

CLEVELAND SPEED VARIATOR

varies gas feed to annealing furnace need





THIS gas blower is part of the monogas system that feeds an annealing furnace. Rate of gas output from the blower is precisely controlled by a Cleveland variable speed drive.

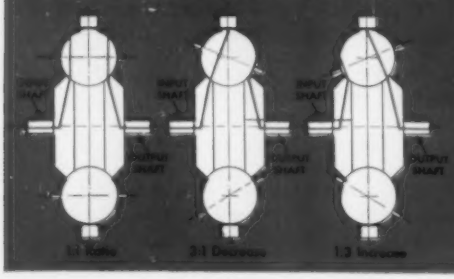
When the gas production rate must be decreased or increased to fit various annealing processes, it is easily regulated by a simple turn of the hand wheel on the drive. To maintain uniform supply of gas at all times, even if pump or compressor output varies, a simple adjustment on the Variator compensates and keeps the production rate steady.

This is one of hundreds of different applications of this unique Cleveland Speed Variator. Engineers and designers have put thousands of units into use on such diverse equipment as cigarette-making machines, textile machinery, metalworking machinery, pharmaceutical equipment, transfer tables, conveyors, testing equipment and experimental machines of many types.

Being infinitely variable, the Cleveland gives stepless speeds over a full 9:1 range—from ⅓ to 3 times input speed. Output speed on this particular application illustrated is adjusted by hand wheel, but could be regulated by either manual or automatic remote control. The Variator is available in 18 sizes, ranging from fractional to 16 hp at 1750 input rpm.

Write for Bulletin K-200 for detailed description with photographs, sectional drawings, rating tables and specifications.

HOW THE CLEVELAND SPEED VARIATOR WORKS



Power is transmitted from input shaft to output shaft through alloy steel driving balls which are in pressure contact with discs attached to the two shafts.

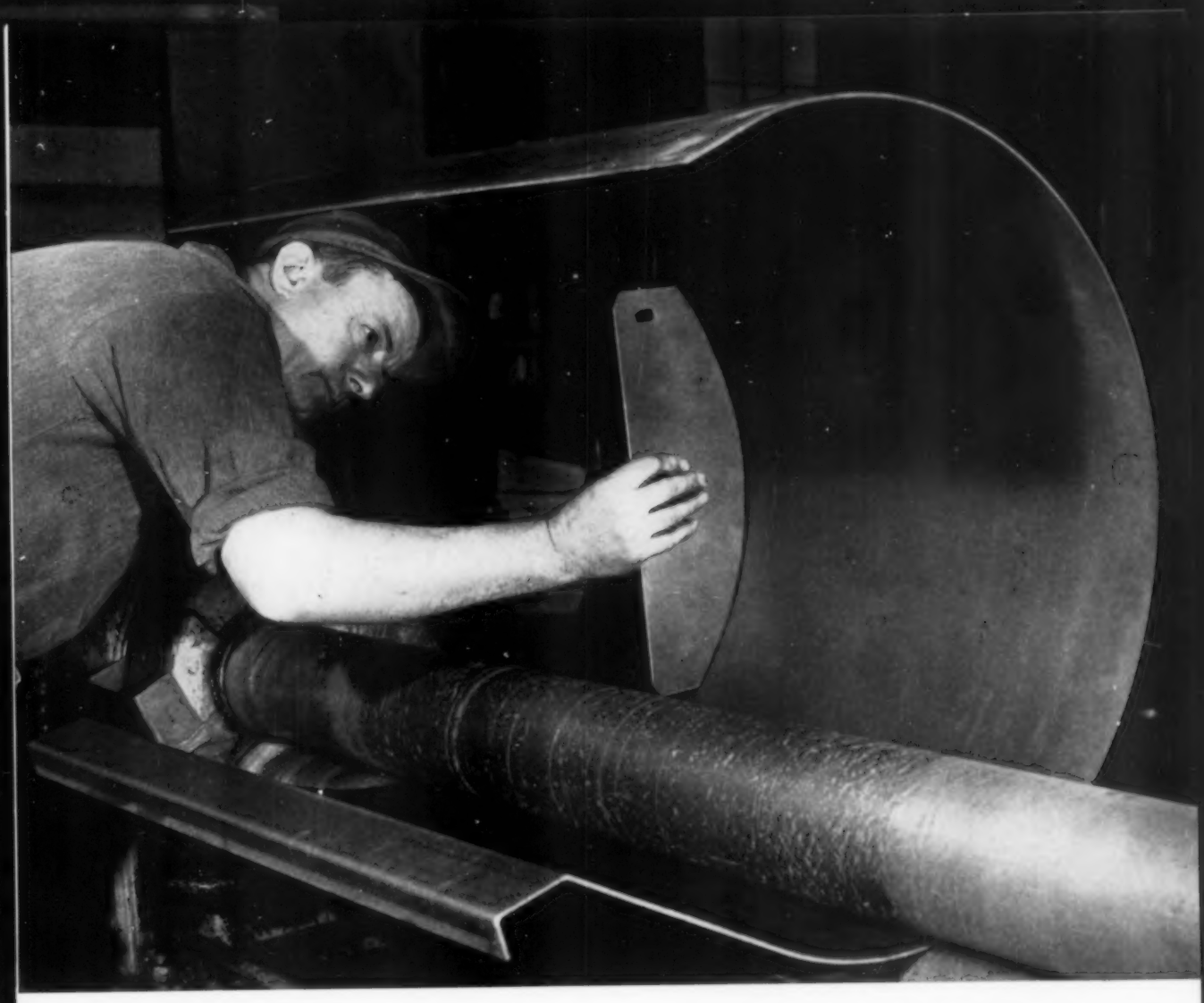
Relative speeds of the shafts are adjusted by changing the positioning of axles on which the balls rotate (diagram, right, shows cutaway Variator with hand regulating wheel).

"It's the Drive That's on the Ball."

THE CLEVELAND WORM AND GEAR COMPANY

Speed Variator Division, 3279 East 80th Street, Cleveland 4, Ohio

Sales Representatives in all major industrial markets • In Canada—Peacock Brothers Limited



How Mayari R lengthened the life of these mixer drums

Mixing mortar or terrazzo in a machine like this one puts the steel mixing drum through quite an ordeal. In earlier models the abrasive action of the batch against the drum walls caused excessive wearing of ordinary carbon-steel drums.

For longer drum life the Muller Machinery Co., Inc., of Metuchen, N. J., decided to utilize the superior abrasion-resistance of Mayari R steel. Now, using Mayari R sheet as heavy as 4-gage, they rotary-shear it, multiple-punch it, roll-form it, and weld it into a drum that outlasts the previous drums of carbon steel. And Mayari R has proved to be as readily workable and weldable as the steel they had used before.

Abrasion-resistance is by no means the only advantage to be gained in using Mayari R high-strength, low-alloy steel. Its high yield point permits designs of greater strength or lighter weight. It has 5 to 6 times more resistance to atmospheric corrosion than plain carbon steel, and holds paint up to 80 pct longer.

Catalog 353 covers the Mayari R subject in complete detail. A copy may be obtained promptly by writing to the nearest Bethlehem office.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

Mayari R...High-Strength, Corrosion-Resisting Steel

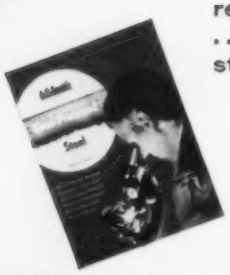
BETHLEHEM STEEL

Is this the answer to your product problem?

FACILITIES + SKILL FOR PROTECTING STEEL WITH GLASS

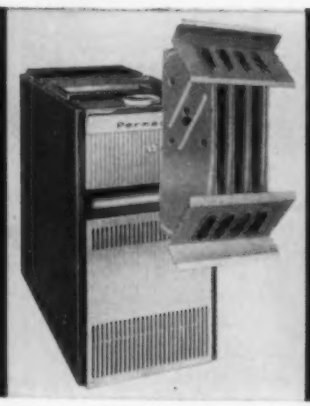
Now at your service

research and production resources of A. O. Smith ... world's largest manufacturer of glass-protected steel products for home, farm and industry



For today's problem products or tomorrow's product problems — A. O. Smith glass-protected steel may be just what you need. Free folder details its many unique properties and broad service range. Write for it today!

PERMAGLAS water heaters . . . set new standards of life expectancy in tank linings.



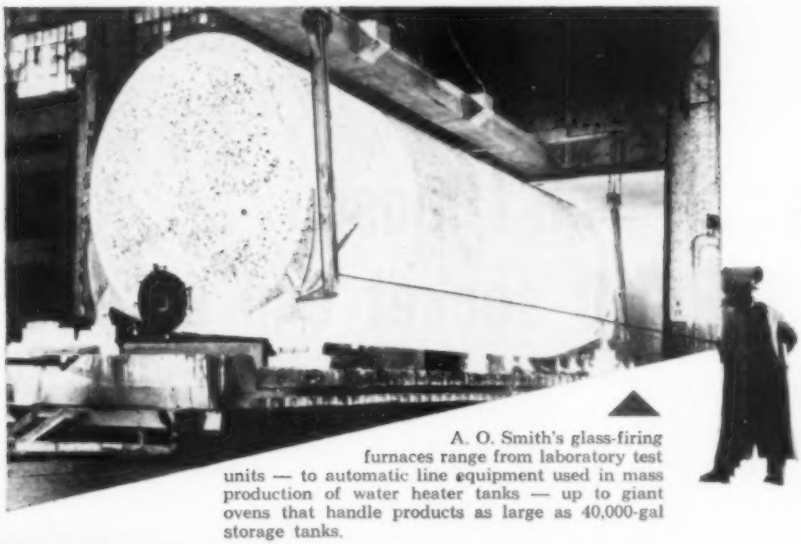
PERMAGLAS home heating and cooling . . . ceramic-coated heat exchangers prevent oxidation and condensate corrosion.

HARVESTORES for farm feed processing . . . *Permaglas* mechanized storage structures, handling industrial bulk materials, turn losses to profits.

GLASCOTE subsidiary products for severest chemical processing service . . . defeat corrosion and contamination.

Each glass formula starts with the careful weighing of sands, clays and other specified ingredients. These are then thoroughly mixed and screened to uniform consistency.

A special smelter liquifies the mixture at 2300° F. This molten "lava" is poured into cold water where it solidifies and shatters into glass particles called *frit*. (Not illustrated: *Frit* is ground with special clays and soft water in giant ball mills to produce a creamy liquid called *slip*. This is applied to steel surfaces that have been cleaned and etched to provide a perfect bonding texture).



A. O. Smith's glass-firing furnaces range from laboratory test units — to automatic line equipment used in mass production of water heater tanks — up to giant ovens that handle products as large as 40,000-gal storage tanks.

The actual fusing of glass to steel takes place in special furnaces super-heated to 1600° F. The bond is both physical and chemical . . . and the glass will not separate from the steel until the metal's yield point has been exceeded.

PERMAGLAS beer storage tanks . . . guard product flavor, purity and uniformity.

Through research A.O. Smith *. . . a better way*

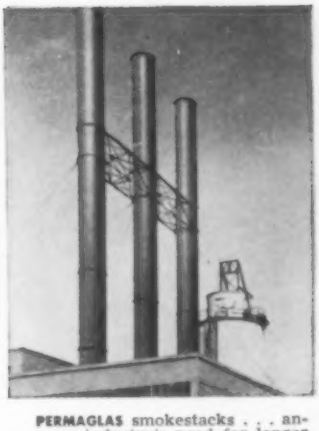
A.O.Smith

CORPORATION

MILWAUKEE 1, WISCONSIN

12 plants in New Jersey, Pennsylvania, Ohio, Illinois, Wisconsin, Texas and California

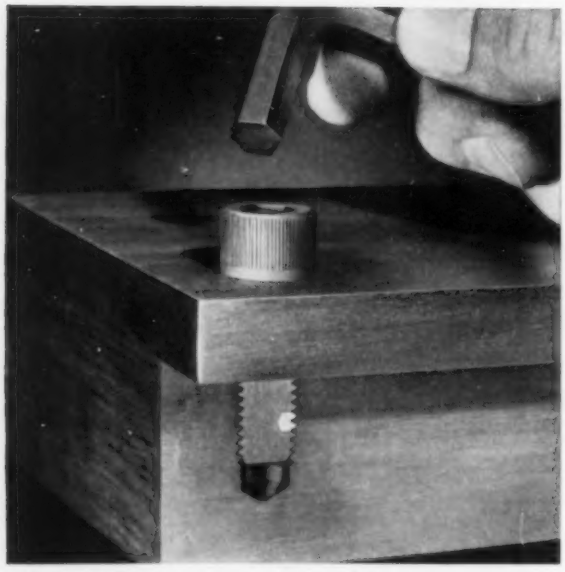
International Division: Milwaukee 1, Wisconsin



PERMAGLAS smokestacks . . . answer industry's need for longer smokestack life . . . economically.

The ordinary fasteners securing the worm wheel to the drum shaft in this automatic screw machine loosened, causing $120 worth of damage to parts. Labor for the repair job cost $100. The ordinary fasteners were replaced with self-locking UNBRAKOS, and there has been no trouble since.

Vibration won't loosen self-locking UNBRAKO socket cap screws



HOW IT LOCKS. The tough, resilient Nylok locking pellet keys itself into the mating threads. It forces threads together and locks the screw securely—whether or not the screw is seated.

UNBRAKO socket screws with the Nylok* self-locking device eliminate fastener problems caused by vibration.

Take the drive system in the automatic screw machine illustrated above, for example. The screws originally used to secure the worm wheel to the drum shaft loosened, causing considerable damage, besides loss of production time. These have now been replaced with self-locking UNBRAKO socket head cap screws and the trouble has been eliminated.

An UNBRAKO socket screw with the Nylok self-locking device is a single unit. Just screw it into any tapped hole. Seated or not, it locks positively wherever wrenching stops. Constant vibration or endless running of a machine won't affect these self-locking UNBRAKOS. The screws will not work loose!

Write today for your copy of Form 2193, which gives catalog and technical data on the complete line of UNBRAKO socket screws with the Nylok self-locking device. Or see your local industrial distributor. Unbrako Socket Screw Division, STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.

UNBRAKO SOCKET SCREW DIVISION

STANDARD PRESSED STEEL CO.

SPS

JENKINTOWN PENNSYLVANIA

*T.M. Reg. U.S. Pat. Off., The Nylok Corporation

MORE THAN *50,000 DIFFERENT SPECS* HAVE BEEN FILLED BY THESE 6 HOWARD UNIVERSAL AND D.C. FRACTIONAL H.P. MOTORS

These 6 Howard motors account for over 50,000 specifications, both military and commercial. One reason for this wide use is Howard's ability to produce variations *exactly* suited to specific needs.

Howard motors have such field-proven engineering features as automatic slot cell insertion, which practically eliminates "grounds;" Zanderoll processed double dipped and double baked armatures providing deep, uniform varnish penetration for high bond strength and rock-hard coils minimizing "shorts and opens;" improved brushholder construction for accurate alignment and longer life; 2-stage, 3-plane dynamic balancing; and automatic winding for tough compact coils, giving uniform performance.

If you are currently using universal and D.C. motors from 1/200th to ½ H.P., check with Howard today.

GEAR REDUCTION UNITS

Model	Ratio	
	min.	max.
11A	3:1	2700:1
Imperial	3:1	2700:1
100	3:1	2700:1
512	3:1	2700:1
700	21.5:1	2600:1
1100	3:1	2700:1

ELECTRICAL SPECIFICATIONS

	MODEL 11A		MODEL IMPERIAL		MODEL 100		MODEL 700		MODEL 512		MODEL 1100	
	SERIES MOTOR	SHUNT MOTOR	SERIES MOTOR	SHUNT MOTOR	SERIES MOTOR	SHUNT MOTOR	SERIES MOTOR	SHUNT MOTOR	SERIES MOTOR	SHUNT MOTOR	SERIES MOTOR	SHUNT MOTOR
NO LOAD SPEED (RPM)	15M	3.5-10M	18M	2-10M			@ 15M	3.5-10M	15M	2-9M	18M	9M
FULL LOAD SPEED (RPM)	5-10M	3-8M	5-10M	1.5-8M	5-10M	1.8-6M	5-10M	3-8M	5-10M	1.8-6M	5-10M	1.8-6M
MAX. H.P. CONT. @ MAX. R.P.M.	1/75 No Fan	1/75 No Fan	1/15	1/20	1/50	1/50	1/50	1/50	1/10	1/12	1/3	1/8
MAX. H.P. INTER @ MAX. R.P.M.	1/20	1/20	1/8	1/10	1/13	1/13	1/15	1/15	1/5	1/6	1/2	1/4
FULL LOAD AMPS. CONT. @ 115V	.4	.4	1.1	1.1	.35	1.6 at 24V	.60	.45	1.5	1.5	2.2	1.7
FULL LOAD AMPS. INTER @ 115V	.75	.75	2.0	2.0	1.0	5 at 24V	.70	.90	3.0	3.0	4.4	3.0
% EFF. AT FULL LOAD CONT.	30	30	35	30	35	35	40	35	50	45	38	30
% EFF. AT FULL LOAD INTER.	35	35	50	45	45	45	45	45	60	55	55	55
VOLTAGES	12-115	6-120	24-115	6-120	12-120	6-32	12-230	6-120	24-230	12-230	24-115	6-230
ROTATION	CW, CCW, REV.	CW, CCW, REV.	CW, CCW, REV.	CW, CCW, REV.	CW, CCW, REV.	CW, CCW, REV.	CW, CCW, REV.	CW, CCW, REV.	CW, CCW, REV.	CW, CCW, REV.	CW, CCW, REV.	CW, CCW, REV.

Maximum H.P. ratings are shown. Variations are available for less power to meet application requirements.

Other Howard motors: UNIVERSAL & D.C. 1/200 to 1/2 h.p. • SHADED POLE 1/2000 to 1/8 h.p. INDUCTION 1/1400 to 1/8 h.p. • SERVO MOTORS • GEAR MOTORS • BLOWERS

HOWARD

HOWARD INDUSTRIES, INC., 1750 STATE ST., RACINE, WIS., TELETYPE: RAC 344

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DIVISIONS: EMC ELECTRIC MOTOR CORPORATION · CYCLOHM MOTOR CORPORATION · RACINE ELECTRIC PRODUCTS

Hyatt's Simplified Fitting Practice for Bearing Races

HYATT pioneered the use of carburizing type alloys in order to obtain the advantages of heavier race fits

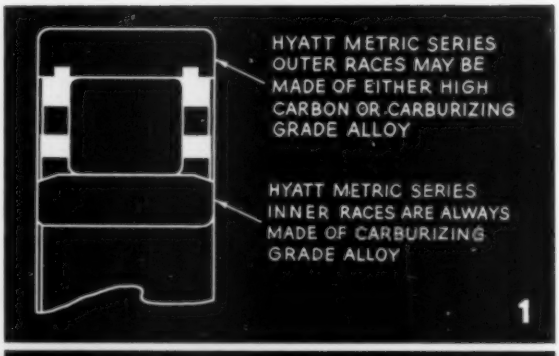
To obtain the best possible performance, roller bearing races must be assembled on shafts and in housings with certain fits developed by design and experience. The most frequent condition to be met is a rotating shaft where specific load and speed conditions must be satisfied with appropriate race fits. These vary according to the manufacturer, and in the case of some manufacturers, according to the application. Naturally, the fits will also vary according to bearing type and size.

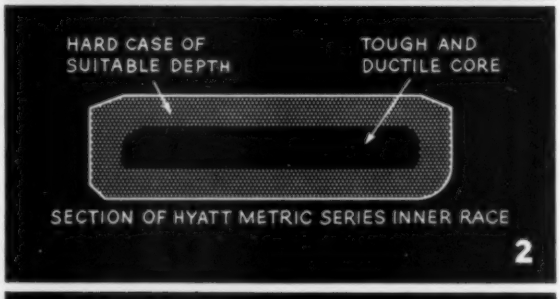
1. CARBURIZING PERMITS HEAVIER INTERFERENCE FITS

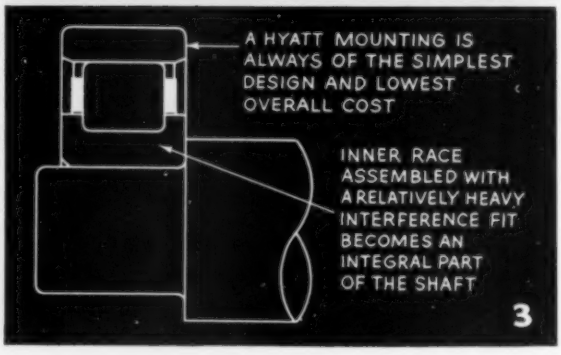
Taking the standard metric series of cylindrical roller bearings for an example, the bearing user has the choice of two fitting practices. One involves the use of inner races made of through-hardening steel, which dictates fairly light interference fits to avoid splitting. The other utilizes races made of low carbon steel *carburized* and hardened to develop a suitable surface hardness and a tough ductile core. The latter permits much heavier interference fits and has the additional advantage of eliminating all auxiliary holding devices, because the race becomes practically an integral part of the shaft. (Figs. 1, 2.)

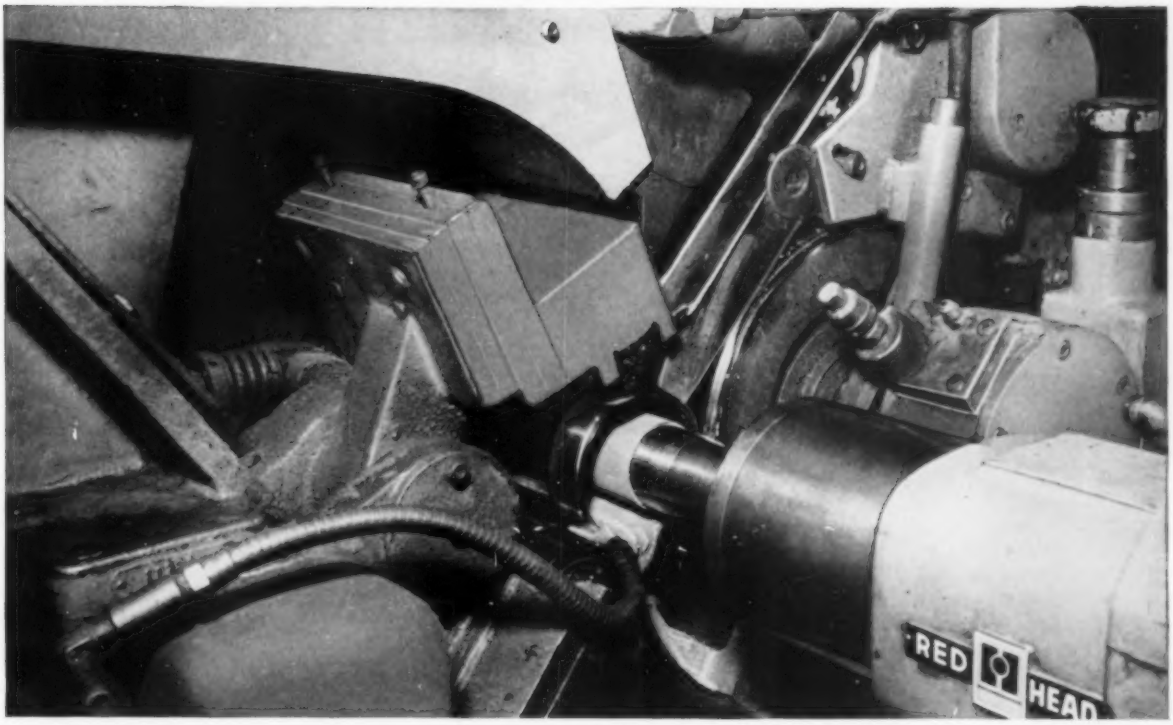
2. HEAVIER FITS SIMPLIFY MOUNTING, REDUCE COSTS

Hyatt originated the carburized race and the system of relatively heavy inner race fits to simplify bearing mounting and eliminate the need for retaining devices. Practically all HYATT inner races are made from nickel alloys of the carburizing type. They permit mountings of the simplest type and lowest over-all cost. Furthermore, the shoulders of HYATT carburized races will withstand considerably greater impact loads than will ordinary races. (Figures 3 and 4.)


HYATT METRIC SERIES OUTER RACES MAY BE MADE OF EITHER HIGH CARBON OR CARBURIZING GRADE ALLOY
HYATT METRIC SERIES INNER RACES ARE ALWAYS MADE OF CARBURIZING GRADE ALLOY
1




A HYATT MOUNTING IS ALWAYS OF THE SIMPLEST DESIGN AND LOWEST OVERALL COST
INNER RACE ASSEMBLED WITH A RELATIVELY HEAVY INTERFERENCE FIT BECOMES AN INTEGRAL PART OF THE SHAFT
3

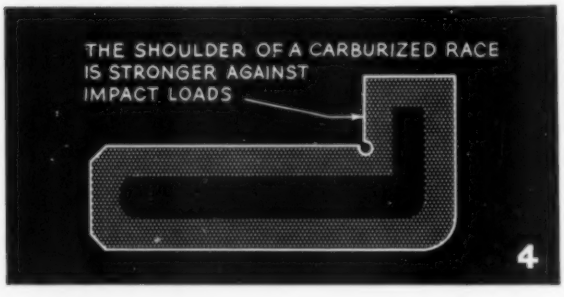


Hyatt inner race being centerless I. D. (inside diameter) ground to close tolerances.

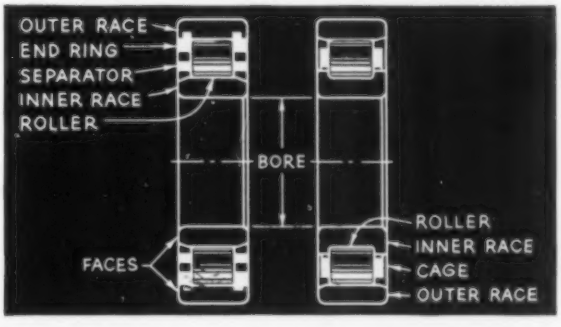
There are two fitting specifications which apply to HYATT inner races, depending on whether the inner race rotates or is stationary in operation. Remember, with both inner and outer race, the rotating member is assembled with heavier fit.

3. HYATT INNER RACES CAN BE EASILY SHRUNK ON SHAFTS

HYATT inner races may be mounted on shafts by pressing or shrinking. Where shrinking practice is employed, first heat the race in oil held at a temperature not over 300°F, or in an electric oven under a similarly controlled temperature, until it expands sufficiently to be slipped into position. The required interference fit will develop as the race cools in place. For special conditions of fit involving hollow shafts of varying sections or multiple housings of dissimilar metals, consult your HYATT Sales Engineer from our nearest sales office.



COMPONENT PARTS OF A HYATT ROLLER BEARING



YOU WILL FIND MORE DETAILS in HYATT Catalog No. 150. If you do not have a copy, write Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey. Sales offices at Harrison, Pittsburgh, Chicago, Detroit and Oakland, California.

GM GENERAL MOTORS

HYATT HY-ROLL BEARINGS FOR MODERN INDUSTRY

CAKE MIX IN A "JIFFY" WITH

CYPAK

Controlling automatic storage conveyors at Chelsea's modern food plant

Chelsea Milling Company, maker of well-known "Jiffy" brand premixed foods, uses flexible CYPAK* static control to reduce material handling costs in their plant at Chelsea, Michigan.

CYPAK begins at the mixing and packaging machines, memorizing the sequence of cartons going to the warehouse. Cartons are identified automatically, and then CYPAK directs storage according to the preselected pattern.

Subsequent delivery of cartons from storage to dock is also completely predetermined, making the warehousing operation totally automatic. An additional benefit realized by Chelsea with this system has been great reduction in carton breakage.

For complete information on CYPAK, call your Westinghouse representative, or write Westinghouse Electric Corporation, P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pennsylvania.

*Trade Mark

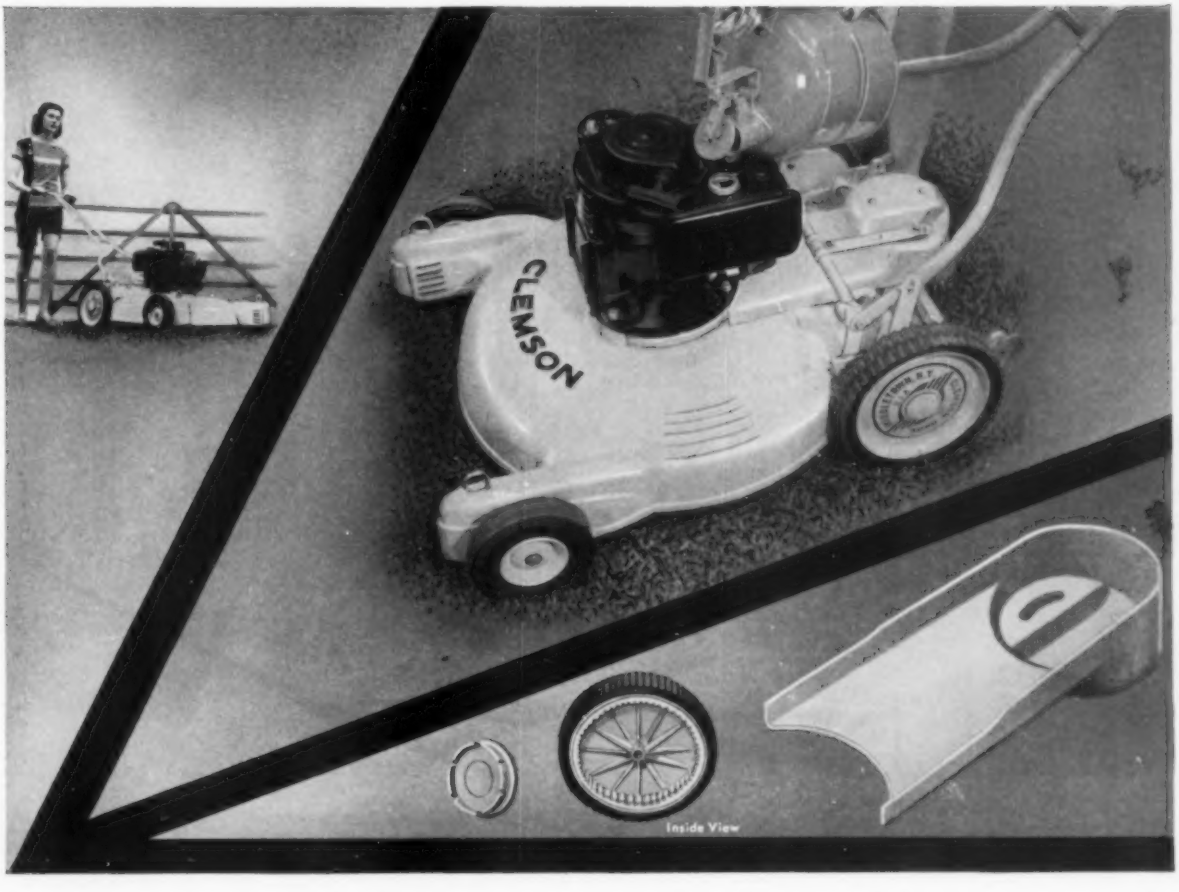
J-22033

YOU CAN BE SURE... IF IT'S

Westinghouse

Mr. Lester L. Bosch, Partner, Bosch & La Tour views their system design.

Naugatuck Kralastic



Kralastic "moves" Clemson Power Mowers*

The severe thrust action developed by self-propelled rotary mowers previously required metal gears and wheels. Now Clemson Mowers employ Naugatuck's Kralastic® to absorb this punishing impact and thrust. In addition to the geared drive wheels, Kralastic is also being used for the front wheels, the belt housing, hub caps and wheel seal rings.

With its tremendous impact strength, Kralastic stands up under season-after-season abuse. It won't become misshapen or broken; even if stepped on or kicked, it won't dent. The color won't chip, crack, or peel off; it's molded right into each unit. And, unlike most metals, Kralastic absorbs sound and vibration, can't rust, rot or corrode.

An easily molded rubber-resin blend, Kralastic offers you many opportunities to improve your products' performance *and* increase their sales appeal. Why delay ... send for complete information TODAY.

*Manufactured by Clemson Bros., Inc., Middletown, New York.

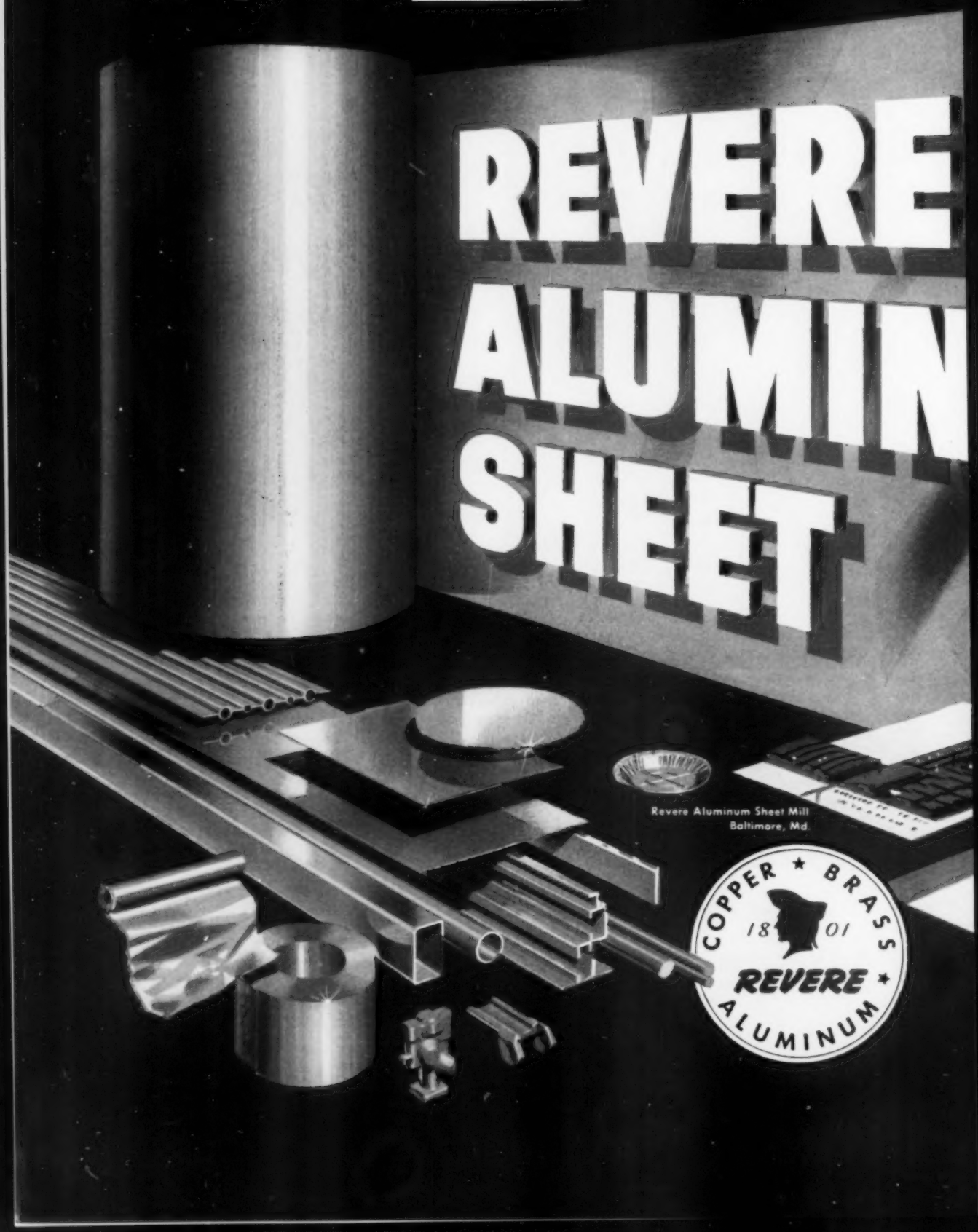
United States Rubber

Naugatuck Chemical Division

Naugatuck, Connecticut

BRANCHES: Akron • Boston • Gastonia, N. C. • Chicago • Los Angeles • Memphis • New York • Phila.
IN CANADA: Naugatuck Chemicals, Elmira, Ontario • Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices • Cable Address: Rubexport, N.Y.

Ready, Set, GROW...with



New Revere Aluminum Sheet Mill
Chicago, Ill.

You will find that Revere Aluminum Sheet passes smoothly and economically through your processes, that it brings to your products all the advantages you expect from fine aluminum.

Three Revere plants, located in the East, the Mid-West and on the Pacific Coast, can bring mill service and technical consultation close to your own doorstep. These plants will have the backing of Revere's primary aluminum operation, scheduled to begin production in 1958.

It will pay you to tie the growth of your business to the most dependable sources of supply—such as Revere, which is in aluminum in a BIG WAY. Revere Copper and Brass Incorporated. Founded by Paul Revere in 1801. Executive Offices: 230 Park Avenue, New York 17, N. Y.

Revere Aluminum Mill Products include coiled and flat sheet, both plain and embossed, circles, blanks, Tube-In-Strip, extruded products, seamless drawn tube, welded tube, rolled shapes, electrical conductors, forgings, foil and frozen food containers.

← Projected for 1957: New Revere Aluminum Sheet Mill Santa Ana, Calif.

HOW USS "T-1" STEEL IMPROVES

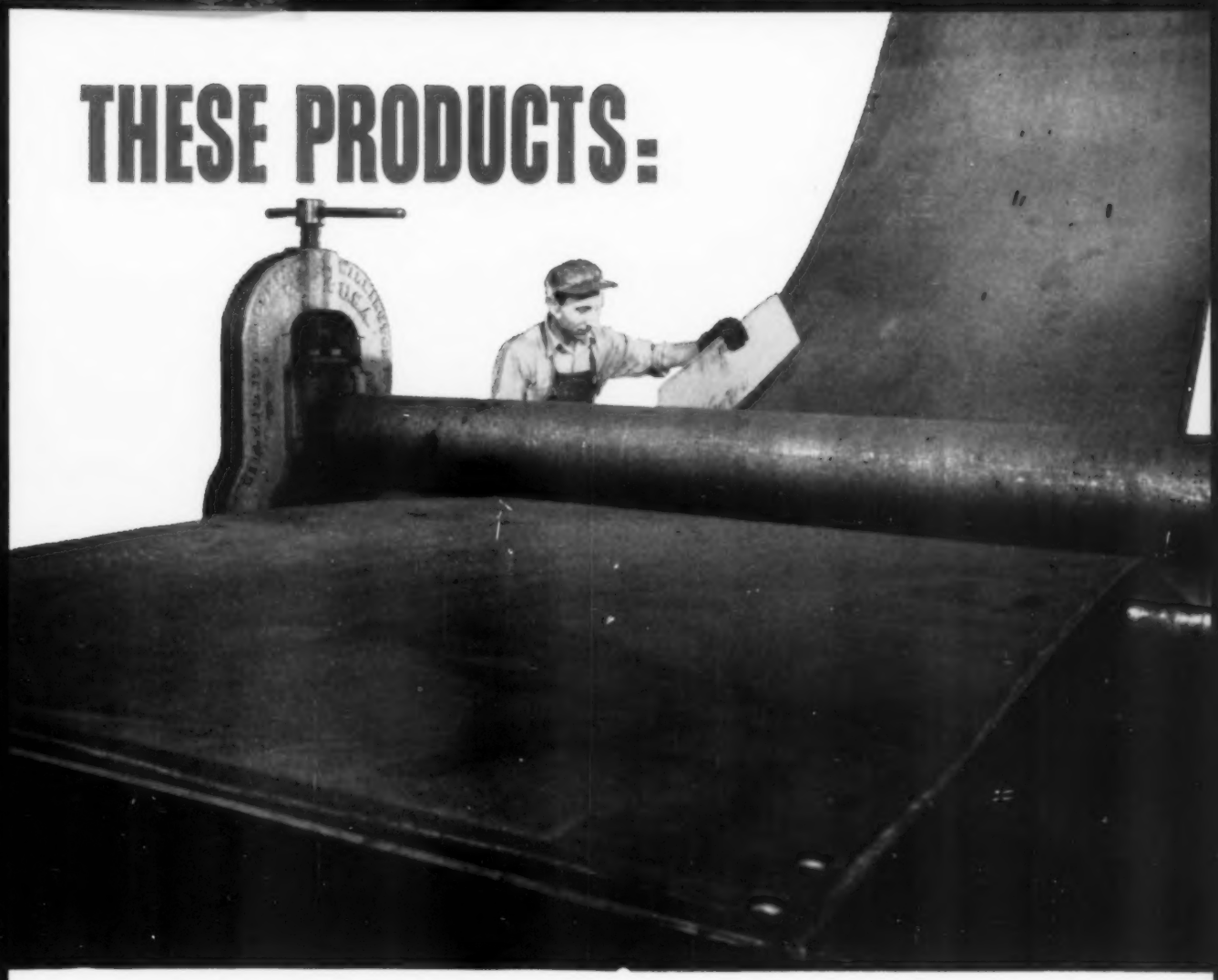
▲

Eliminates Normalizing. A-1 Bit and Tool Company, Houston, Texas, has converted exclusively to USS "T-1" Steel for jigs and fixtures on its turret lathes. The reason: USS "T-1" Steel, being already heat-treated, doesn't require normalizing before final machining. "T-1" doesn't warp and distort during welding, and it is easy to weld. Jigs now are machined, welded, and ready for mounting. USS "T-1" Steel saves money, speeds production, and reduces rejects.

◀

Increases Durability of Buckets. Oaks Welding, Incorporated, Columbiana, Ohio, repairs mining equipment on a custom basis. They rebuilt the 4½-yd. dragline bucket shown here with USS "T-1" Steel. Sides, bottom, and runners were made from USS "T-1" Steel . . . are actually far stronger and more durable than when the shovel was new . . . are better able to withstand severe impact abrasion in all kinds of weather.

THESE PRODUCTS:



Simplifies Fabrication. Fairmont Machinery Company, Fairmont, West Viriginia, is using USS "T-1" Steel in thicknesses up to ⅜ inch to build an *unlined* coal storage bin. "T-1" Steel's abrasion and corrosion resistance make it an ideal choice for this type of service. In fabrication, high-yield-strength USS "T-1" Steel was cold formed on equipment normally used to form carbon steel.

This new coal storage bin will be welded in the field to cut costs. It will be simpler to build because it will need fewer stiffening members and will be lighter in weight than typical coal storage bins.

HOW IT CAN HELP YOU

USS "T-1" Steel, with its high minimum yield strength of 90,00 psi and its minimum tensile strength of 105,000 psi, can help you design or build lighter-weight equipment that will last longer. Its unusual toughness can help you design or build equipment capable of taking severe impact abuse at sub-zero temperatures. Its excellent weldability can help you to cut the cost of fabricating highly stressed parts and to reduce repair and maintenance expenses. Its good creep rupture strength can help you to put more durability in equipment that operates at temperatures as high as 900 degrees F.

Somewhere in your operation, versatile USS "T-1" Steel can help you. Write, wire, or phone United States Steel, Pittsburgh 30, Pennsylvania.

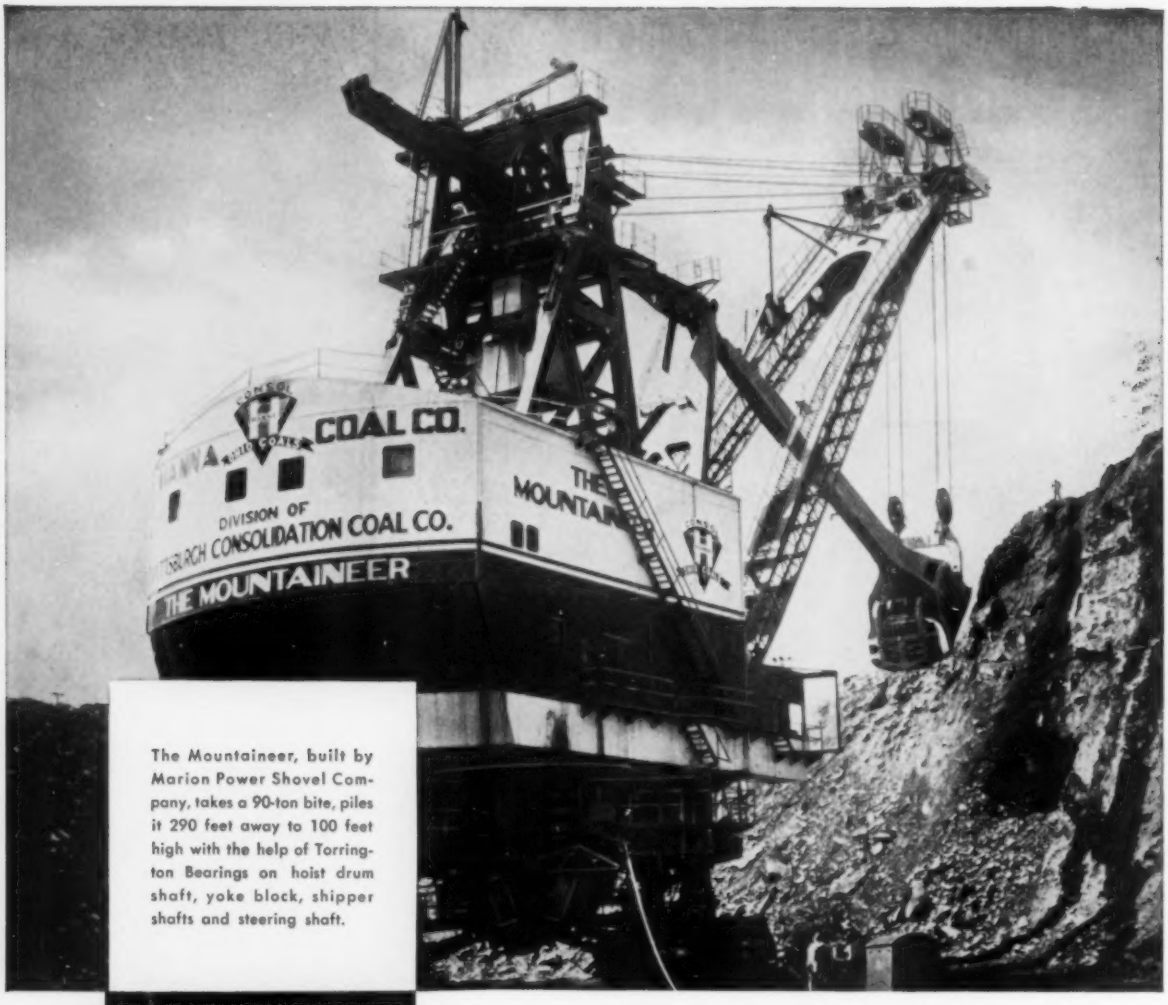
UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

SEE THE UNITED STATES STEEL HOUR. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

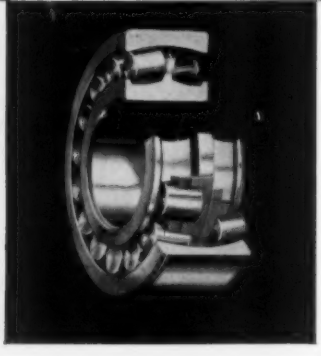
USS "T-1" CONSTRUCTIONAL ALLOY STEEL

"USS" and "T-1" are registered trademarks.

UNITED STATES STEEL



The Mountaineer, built by Marion Power Shovel Company, takes a 90-ton bite, piles it 290 feet away to 100 feet high with the help of Torrington Bearings on hoist drum shaft, yoke block, shipper shafts and steering shaft.



World's Mightiest Lift Transmitted Through Torrington Bearings

The Mountaineer, world's largest power shovel, transmits its mighty lifting power – 250 tons – through two Torrington Spherical Roller Bearings on the hoist drum shaft.

Here these bearings operate smoothly at full capacity despite shaft deflections. Four other Spherical Roller Bearings are used in the yoke block to eliminate need for precise alignment of separately bored parts. In all applications, advantages of accurate roller-to-race conformity and positive roller guidance through the integral center flange contribute to long, maintenance-free service life.

To carry thrust of helical gears on shipper shafts and of the steering screw shaft, four Torrington Roller Thrust Bearings are used in each of these assemblies.

Not only in power shovels, but in all kinds of heavy-duty equipment, Torrington Bearings have proved their efficiency and long service life. *The Torrington Company*, South Bend 21, Ind.– and Torrington, Conn.

TORRINGTON BEARINGS

District Offices and Distributors in Principal Cities of United States and Canada

SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • NEEDLE • BALL • NEEDLE ROLLERS • THRUST

Problem: To produce a rugged, dependable motor case for Sunbeam Mixmasters—in sufficient quantity to meet customer's need. Production cost must be low, to keep price competitive.

Solution: Working closely with Sunbeam, Stewart Die Casting engineers developed an intricate two-cavity die, consisting of slide, cores, and one loose piece—all held to extremely close tolerances. The result was a precision casting that can be produced economically with a minimum of rejects . . . a motor case that gives dependable, long-lasting service under all conditions.

Stewart found the solution and made delivery on time!

This is just one of many complicated die castings that Stewart has developed promptly . . . and has produced in quantity *at low cost.*

Nearly half a century of experience, plus unexcelled production facilities, enables Stewart to bring you fast, practical solutions to any die casting problem.

Whatever type of die casting you need—large or small, simple or intricate—you can count on Stewart for a quality job . . . completed and delivered on schedule.

Stewart **DIE CASTING**

Division of STEWART-WARNER CORPORATION

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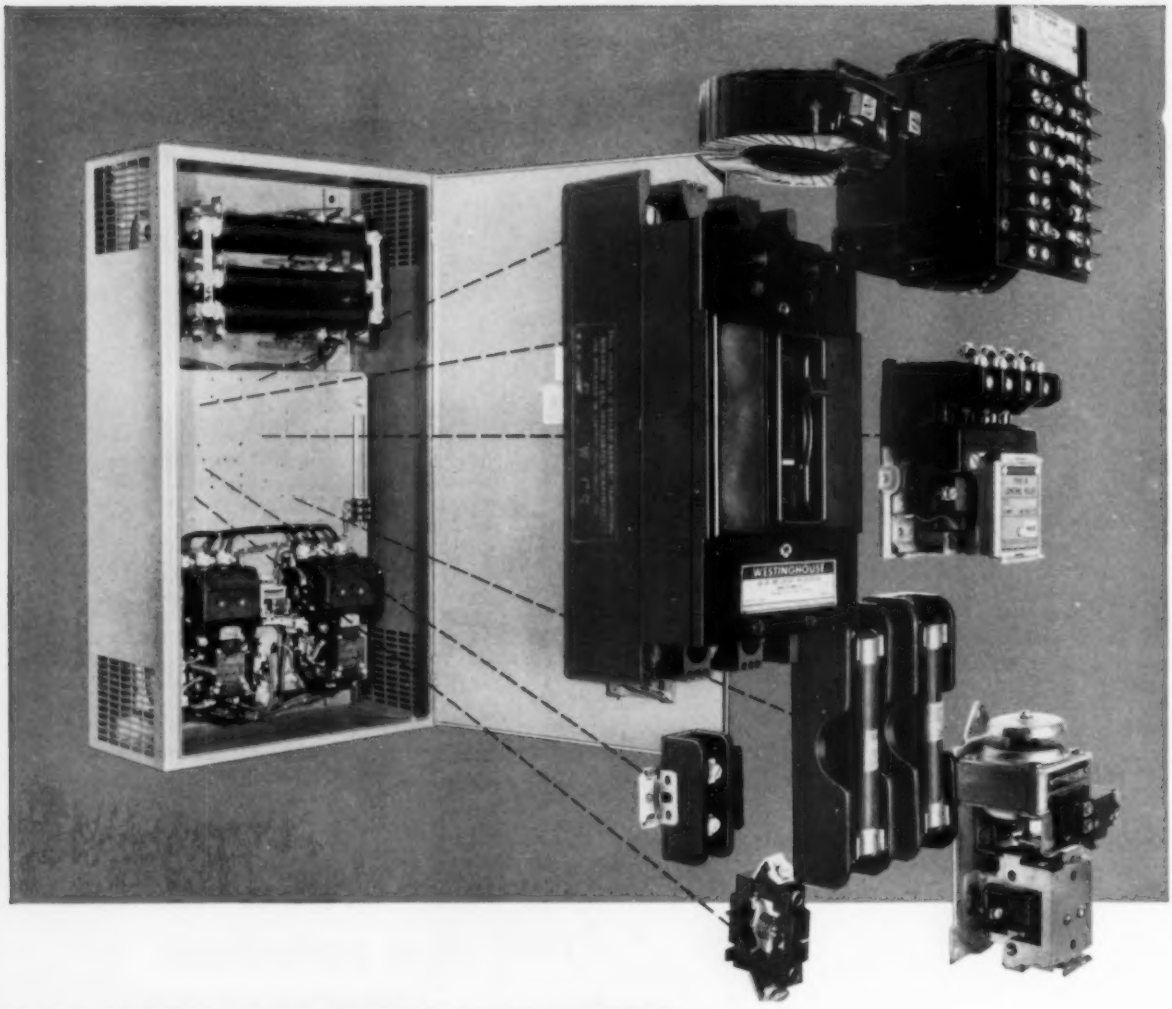
46 YEARS OF SERVICE TO INDUSTRY



REDUCED VOLTAGE STARTER

. . . built to grow with Add-A-Part Panel

Room to grow is built right in at the factory with the Westinghouse Add-A-Part panel. When additions to systems require such modifications as control circuit fuses, auxiliary relays, or current transformers, the space for them is there—engineered right into industry's most advanced reduced-voltage starter.

Other features that make this starter the most flexible, available today include pneumatic types AM and AMB relays for easy, stepless timing adjustment—adjustable resistor taps so you can adjust starting voltages to meet your requirements.

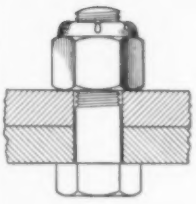
For all the facts, call your Westinghouse sales engineer. Ask for DB 11-500. You'll see one more reason why you can be sure . . . if it's Westinghouse. J-22022

YOU CAN BE SURE...IF IT'S

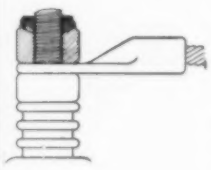
Westinghouse

Ten fastening problems solved by ELASTIC STOP® nuts

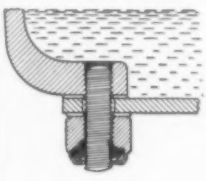
TIGHTENED AGAINST THE WORK



Vibration and impact proof bolted connections in standard applications.

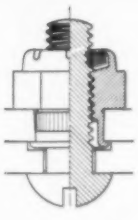


On all electrical terminals subjected to vibration in transit or operation, and for any electrical or electronic assembly where positive contact must be maintained.

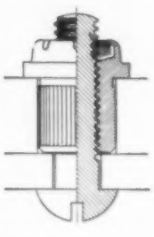


To seal bolt threads where leakage past stud threads must be prevented.

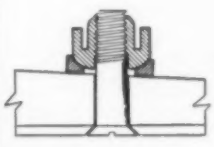
FOR MANY SPECIAL FUNCTIONS



Blind fastening applications where nut is "clinched" into sheet metal . . . becoming self-retaining as well as self-locking.

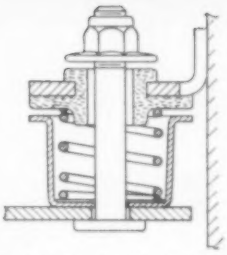


To eliminate drilling and tapping and provide steel thread strength for soft metals, an ESNA spline nut is pressed into a bored hole in casting.

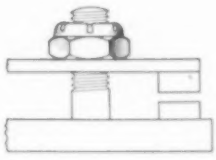


Simplified self-aligning self-locking fastener for bolting two non-parallel surfaces.

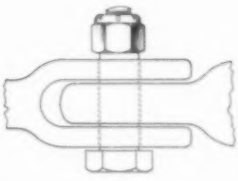
LOCKED ANYWHERE ON THE BOLT



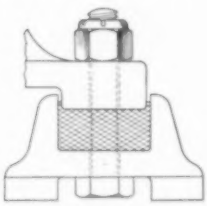
Spring-mounted connections or dynamic balancing, where nut must stay put yet be easily adjusted. (Flanged face eliminates need for extra washers.)



On make and break adjustment studs where accurate contact gaps must be maintained. Note "thin" height design for limited clearance.



For bolted connections requiring predetermined play.



For rubber-insulated and cushion mountings where the nut must not work up or down.

HOW THESE NUTS SOLVE SO MANY FASTENING PROBLEMS, ELIMINATING EXTRA PARTS AND OPERATIONS...

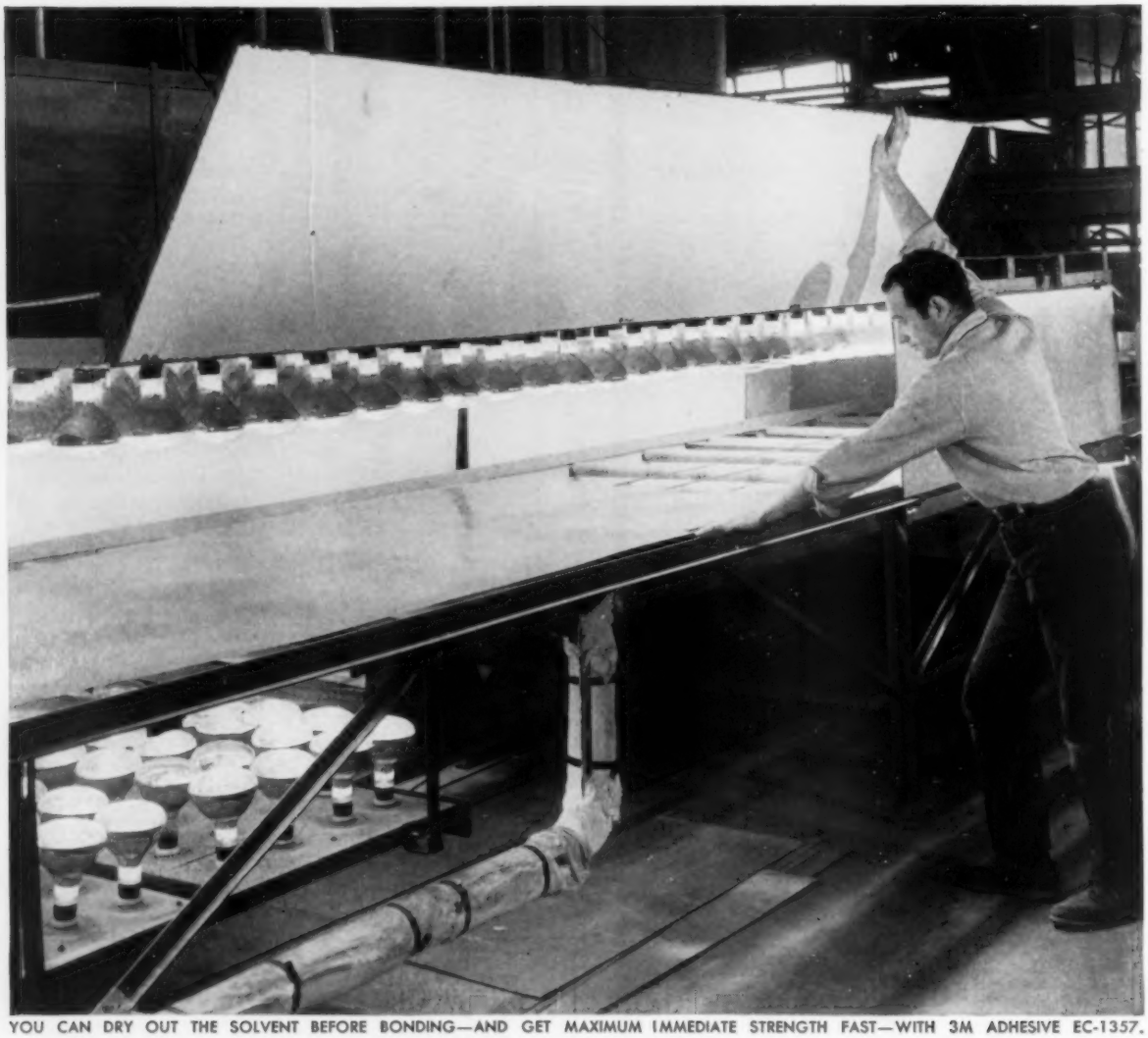
The red locking collar of an ELASTIC STOP® nut grips bolt threads with a perfect fit that will not loosen under severe vibration or stress reversals, and seals against liquid seepage. By bringing nut and bolt metal thread flanks into firm contact it eliminates wear producing axial play. The elastic locking action of the insert-type stop nut does not distort or gall bolt threads. It is reusable many times.

Send for the following free information: Elastic Stop nut bulletin; Rollpin® bulletin. Or enclose a drawing of your product for specific self-locking fastener recommendations. Write to Dept. N30-62.

ESNA®

ELASTIC STOP NUT CORPORATION OF AMERICA
2330 VAUXHALL ROAD, UNION, NEW JERSEY

Speed high-strength sandwich bonding by predrying 3M adhesive EC-1357



YOU CAN DRY OUT THE SOLVENT BEFORE BONDING—AND GET MAXIMUM IMMEDIATE STRENGTH FAST—WITH 3M ADHESIVE EC-1357.

Here's new speed in making light, rugged sandwich panels for non-load-bearing uses!

It's EC-1357. This specially formulated, fast adhesive from the laboratories of 3M gives you high bond strength *immediately!* With infrared ovens, you can dry the solvent out of EC-1357 before bonding. Heat absorption is fast, due to EC-1357's dark color. You eliminate unnecessary drying and storage time. You need no clamps or heated presses, just cold press or nip roller. What's more, this cold bond continues to cure at room temperatures—gains added strength with age.

On metal or paper honeycomb cores, EC-1357 builds up a fillet for bigger bonding area and strength. Use EC-1357 with glass foam cores, too.

SEE WHAT 3M ADHESIVES CAN DO FOR YOU! Consult 3M Research, contact your 3M Field Engineer or write on your company letterhead for information and free literature to: 3M, Dept. 76, 417 Piquette Ave., Detroit 2, Mich.

PRODUCT OF 3M COMPANY RESEARCH

MINNESOTA MINING AND MANUFACTURING COMPANY • ADHESIVES AND COATINGS DIVISION

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Helpful Data from
DE LAVAL

How to calculate the efficiency of worm gearing

The efficiency of worm gearing is determined by frictional losses at the tooth contact, bearings and oil seals plus losses from oil churning and windage. A formula for efficiency at the tooth contact may be developed from a consideration of the forces at the contact. Figure 1 shows these forces acting on a developed section of the worm thread. For simplicity the pressure angle has been assumed to be zero.

The coefficient of friction of the worm and gear is a function of the materials, finish, lubrication and rubbing speed. The latter is the relative speed between a point on the pitch surface of the gear and one on the pitch surface of the worm. The coefficient of friction varies very little at high rubbing speeds but rises with increasing rapidity as the speed drops below 500 fpm.

The efficiency formula developed in Figure 1 involves worm lead angle and the friction angle. Figure 2 provides a relationship between friction angle and rubbing speed based on tests made on accurately manufactured gearing consisting of hardened and ground worm and bronze gear operating in oil.

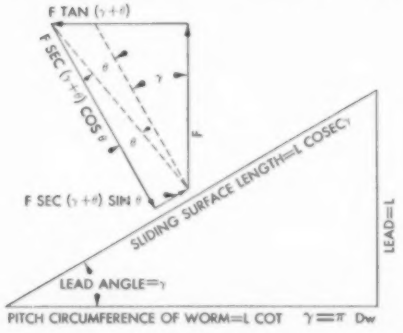
The formula for rubbing speed is:

$$V = \frac{.262\ Dw \times \eta}{\cos \gamma}$$

where

V = Rubbing speed – feet per minute
Dw = Worm pitch diameter – inches
η = Worm speed – rpm
γ = Worm lead angle

FIGURE 1.
Development of equation for efficiency at contact between worm and gear



F = TANGENTIAL FORCE ACTING ON GEAR

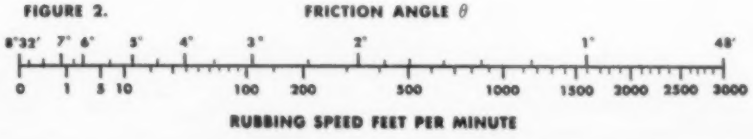
F TAN ($\gamma + \theta$) = TANGENTIAL FORCE APPLIED TO WORM

F SEC ($\gamma + \theta$) COS θ = FORCE NORMAL TO CONTACT SURFACE

F SEC ($\gamma + \theta$) SIN θ = FRICTIONAL FORCE

$$\text{EFFICIENCY} = \frac{\text{WORK REALIZED}}{\text{WORK APPLIED}} = \frac{L \times F}{L \cot \gamma \times F \tan (\gamma+\theta)} = \frac{\tan \gamma}{\tan (\gamma+\theta)}$$

FIGURE 2.



DE LAVAL Worm Gear Speed Reducers Offer Efficiencies to 96%

Ruggedly built for long efficient service De Laval speed reducers are made in horizontal and vertical single reduction units in ratios of 3:1 to 100:1. They are also available in double horizontal and vertical double reduction units as well as in helical-worm and double-worm design. Ratios from 37.8:1 up to 6400:1.

Write for your copies of Catalogs G-WBV and G-WWH to De Laval Steam Turbine Company, Trenton 2, New Jersey.

For a Contact– or a Complete Sub-Assembly... See Mallory

Mallory offers you the savings and convenience of a single source for a simple contact —or a complete contact sub-assembly.

As Mallory has done for many manufacturers, we can consult with your engineers on a contact problem—solve the problem—design the contact element for easy inclusion in an assembly—and, if you want, build the entire sub-assembly for you.

Into this service goes all of Mallory's long experience in the contact field. Mallory metallurgy has equipped them with the best of materials and know-how, for the contact itself—for the backing metal—for design of the housing and for assembly techniques.

The pictured assembly was designed in cooperation with a leading electrical equipment manufacturer. The contacts, conductors, terminal points and the molded plastic case are all cooperative products of Mallory and the customer's engineering and manufacturing abilities. The contact material, Mallory D-54®, permitted the customer's product to pass Navy tests—and at the same time reduced costs by 15%.

So if yours is a contact problem—or a complete contact sub-assembly problem—bring it to Mallory. A single source can expedite your supply and minimize your scheduling problems. Write, or contact the Mallory representative—today, for literature or a consultation.

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"IN STOCK" for immediate delivery.

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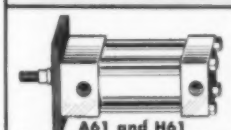
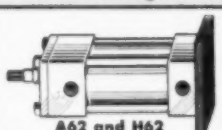
"IN-STOCK" MODELS

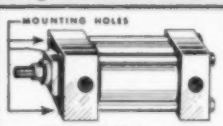
"A" Signifies Miller 200 psi Air Cylinders; "H", 2000 psi Hydraulic Cylinders. Interchangeable Mountings Are Shown In Red On Drawings.



A61 and H61
Flange Mounting on Rod End
(A61 not available in 8" bore)



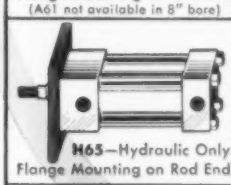
A62 and H62
Flange Mounting on Cap End
(A62 not available in 8" bore)



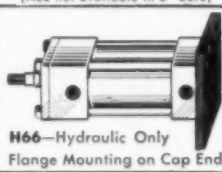
A63—8" Bore only
Flange Mounting on Rod End

A64—8" Bore only
Flange Mounting on Cap End

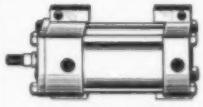
A50 & H50—Tie Rods not extended beyond nuts.
A51 & H51—Tie Rods extended both ends (shown).
A52 & H52—Tie Rods extended. Cap End only.
A53 & H53—Tie Rods Extended. Rod End only.
A54 & H54—Two Tie Rods extended at both ends.



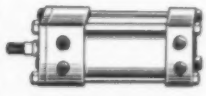
H65—Hydraulic Only
Flange Mounting on Rod End



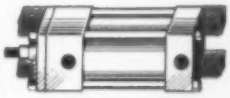
H66—Hydraulic Only
Flange Mounting on Cap End



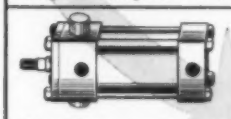
A72 and H72
Side Lug Mounting



A74 and H74
Side Flush Mounting

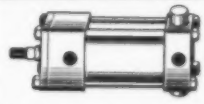


A77 and H77
Side or Foot Mounting

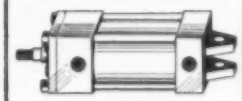


A81 and H81 Trunnion Mounting on Rod End

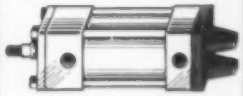
Your Choice of
CAP END CUSHIONED
ROD END CUSHIONED
or
BOTH ENDS CUSHIONED
on all cushioned strokes of all bores shown.



A82 and H82 Trunnion Mounting on Cap End



A84 and H84
Pivot Mounting



A86 and H86
Pivot Mounting

IN STOCK BORES In Inches

"IN-STOCK" STROKES (in Inches)

	BORES	ROD DIA.	ROD TURN DOWN & THREADS		1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
AIR	1½	⅝"	7/16-20	Cushioned			●	●	●	●	●	●	●	●	●	●									
				Non-Cush.	●	●	●	●	●	●	●	●	●	●	●	●									
	2	⅝"	7/16-20	Cushioned			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
				Non-Cush.	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	2½	⅝"	7/16-20	Cushioned			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
				Non-Cush.	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	3¼	1"	¾-16	Cushioned			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
				Non-Cush.	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	4	1"	¾-16	Cushioned			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
				Non-Cush.	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	5	1"	¾-16	Cushioned			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
				Non-Cush.	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	6	1⅜"	1-14	Cushioned			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
				Non-Cush.	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	8	1⅜"	1-14	Cushioned			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
				Non-Cush.	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
HYDRAULIC	1½	⅝"	7/16-20	Cushioned			●	●	●	●	●	●	●	●	●	●									
				Non-Cush.	●	●	●	●	●	●	●	●	●	●	●	●									
	2	1"	¾-16	Cushioned			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
				Non-Cush.	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	2½	1"	¾-16	Cushioned			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
				Non-Cush.	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	3¼	1⅜"	1-14	Cushioned			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
				Non-Cush.	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	4	1¾"	1¼-12	Cushioned			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
				Non-Cush.	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	5	2"	1½-12	Cushioned			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
				Non-Cush.	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

① "A" and "H" Models 82, 84 and 86 with strokes over 18" require stop tubes.

Column strength requires larger diameter piston rods for the following:

Air Cylinder Models A82, 84, and 86 with strokes inside area (1), when operated at 100 psi and over;

All hydraulic models with strokes inside area (2) and Models H82, 84, and 86 with strokes in area (4), when operated at 2000 psi and over;

Models H82, 84 and 86 with strokes inside area (3), when operated at 1000 psi and over.

Depending upon Trunnion Pin location, "A" and "H" Models 83 with standard diameter piston rods can have longer strokes than Models 82, 84 and 86.

See Miller File #251 for oversize piston rod and stop tube requirements.

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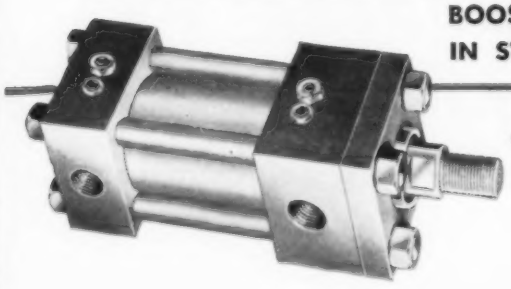

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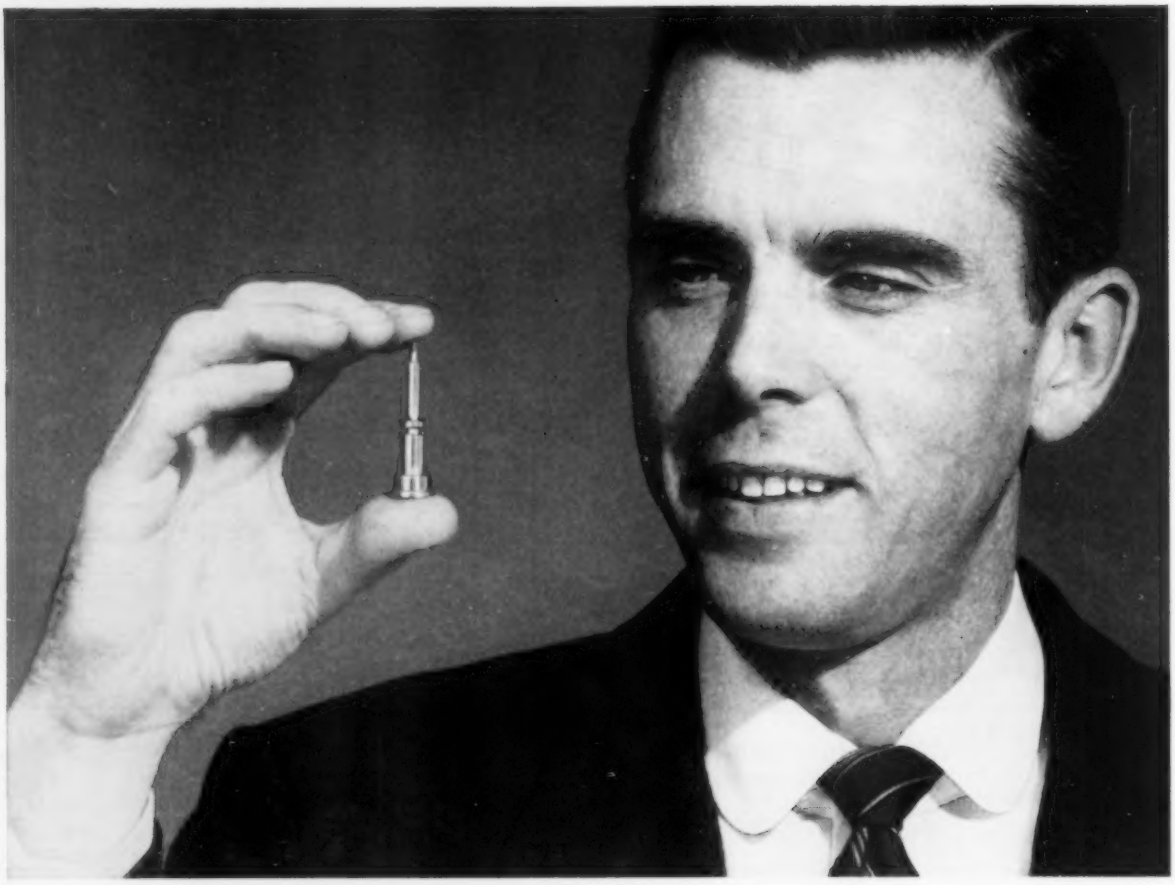

How better machinability in *Carpenter* Stainless changed the machinists' opinion of this design

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Tolerances of .0005" on the parts were very important to successful operation and long service life. The length of the parts made it difficult to cut the threads on the small ends. With the ordinary Type 303 stainless first used, production costs were too high and rejects were excessive.

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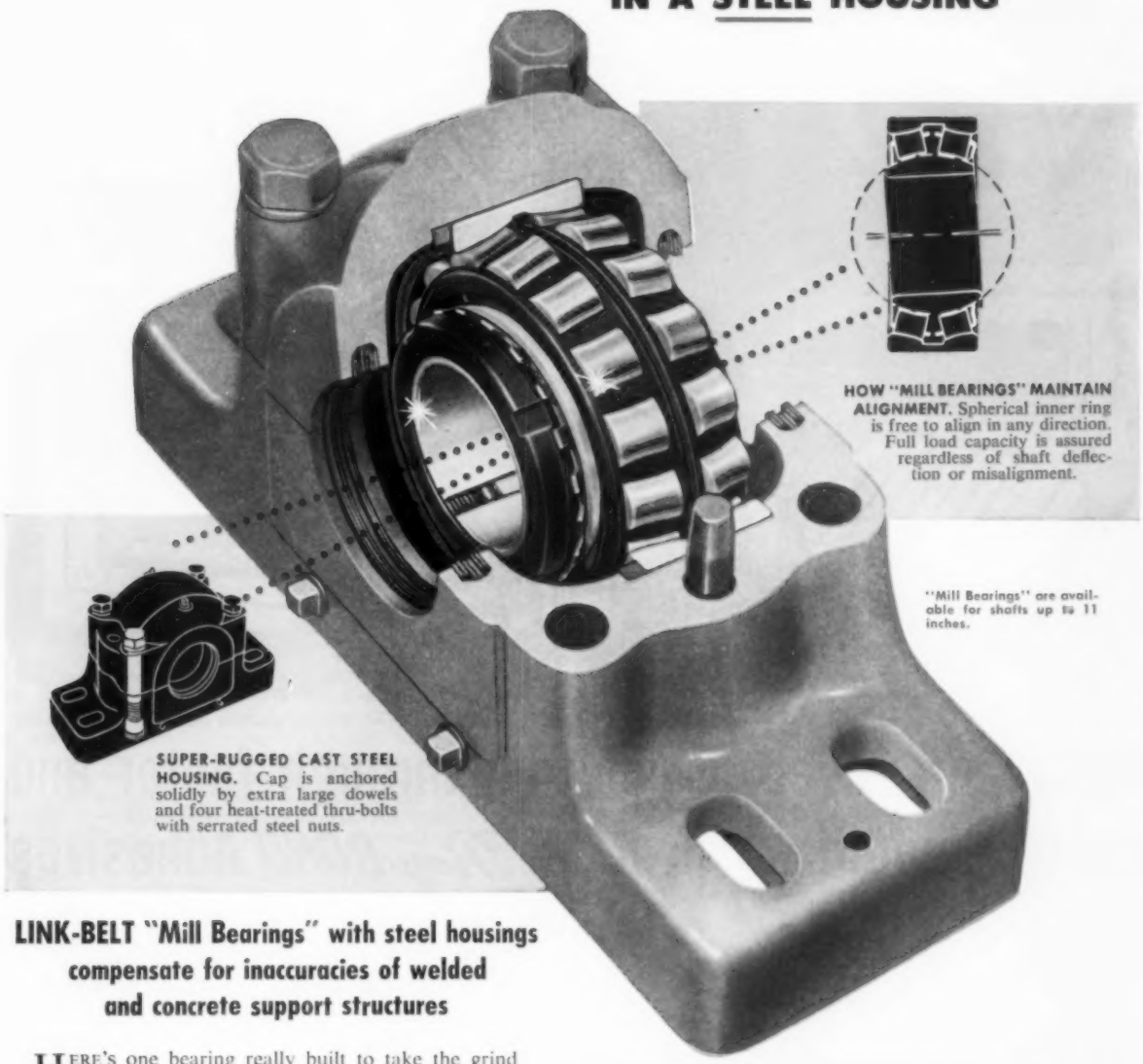
HERE'S self-alignment

IN A STEEL HOUSING



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"Mill Bearings" are available for shafts up to 11 inches.

SUPER-RUGGED CAST STEEL HOUSING. Cap is anchored solidly by extra large dowels and four heat-treated thru-bolts with serrated steel nuts.

LINK-BELT "Mill Bearings" with steel housings compensate for inaccuracies of welded and concrete support structures

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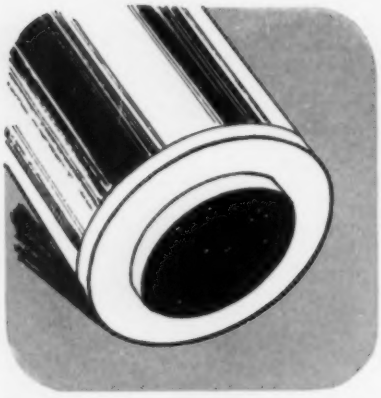


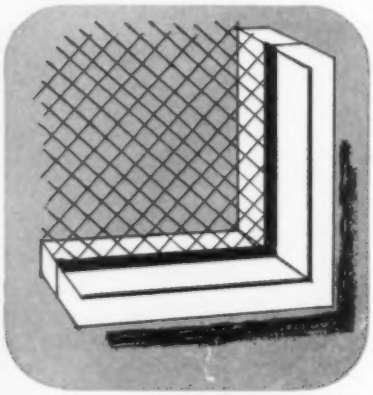
Butyl rubber foot to stainless steel tank

Synthetic foam to metal

Ceramic tips to steel shanks

Natural rubber to clutch pedal

Etched "Teflon"* to steel



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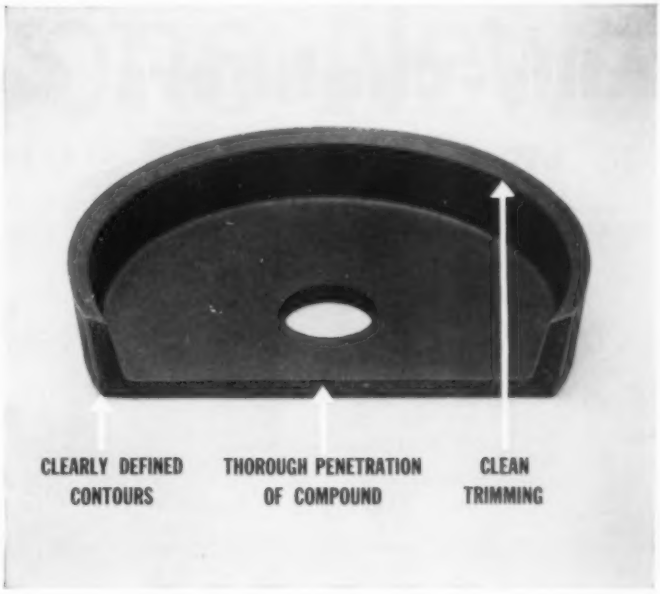
Passaic, N.J.
GRegory 3-2000



R/M SUPER-POWER V-BELTS

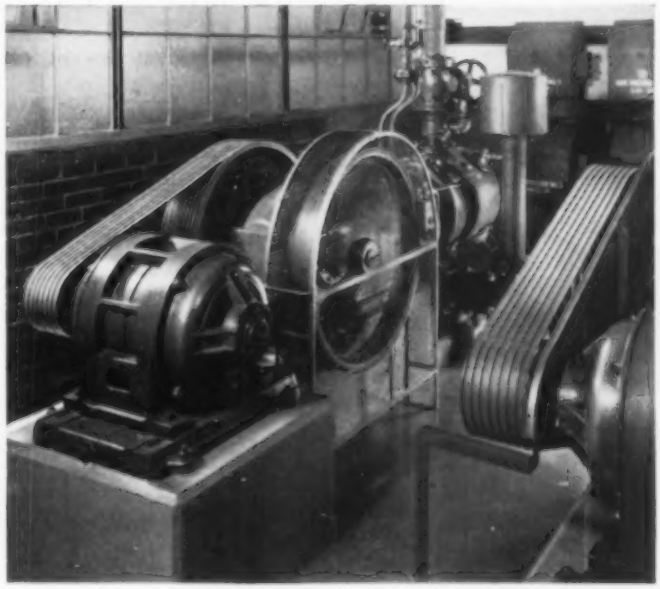
More Power Less Space

New stretchless, super-strength synthetic cords give R/M Super-Power V-Belts extra power capacity for heavy duty drives. This means you can increase drive capacity as much as 40%... *without* changing present drive design. You can save space in *new* drive designs by using *narrower* sheaves and *fewer* belts to meet horsepower specifications! These belts have exceptional resistance to shock loads... virtually eliminate matching problems. Flat sidewalls give them better tensioning and grip, less slip... *longer* life. All-synthetic rubber makes them oilproof and heat resistant. They are also non-spark. The same advanced engineering goes into Condor-V Belts for general drive applications, into R/M Poly-V® Drives, R/M rubber hose, conveyor belt, flat transmission belt and molded or extruded parts. Let R/M specialists help you improve present equipment performance... or solve your next design problem.

*Poly-V is a registered Raybestos-Manhattan trademark.

For booklet shown, or other data, write, phone or wire:

MANHATTAN RUBBER DIVISION
Raybestos-Manhattan, Inc.
Passaic, N.J.
GRegory 3-2000



RAYBESTOS-MANHATTAN, INC.

FACTORIES: Passaic, N.J. • Bridgeport, Conn. • Manheim, Pa. • No. Charleston, S.C. • Crawfordsville, Ind. • Neenah, Wis. • Peterborough, Ontario, Canada

Rubber Lined and Covered Equipment

Sintered Metal Friction Elements

Asbestos Textiles

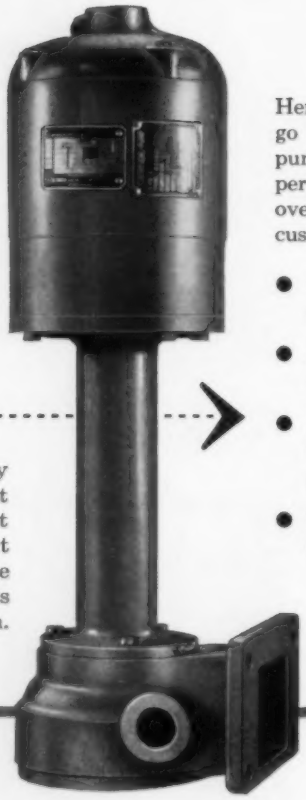
Industrial Adhesives

Teflon Tape, Packings, Sheets, Rods, Tubes

Engineered Molded Rubber and Plastics

R/M

MORE dependability with Allis-Chalmers Coolant Pumps



Here's a complete line of coolant pumps made to go and go on the equipment you build. These pumps have been designed by Allis-Chalmers experts in viscous liquid pumping and will contribute, over the long run, to repeat business from your customers. **Here's why:**

- Sturdy cast iron casing encloses entire unit to assure continued accurate alignment.
- Single-shaft construction maintains maximum rigidity, providing ultimate in bearing life.
- A variety of sealing arrangements are available that need no maintenance nor adjustment once pump is installed.
- The bearings are sealed and operate for years without attention.

These features and many others make A-C pumps right for your application. Find out more from your A-C district office or distributor, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

This Coolant Pump
model is sidewall mounted, is sealless and has open impeller.

Available
in fractional and integral hp sizes, above model is designed for mounting on vertical surface.

Vertically Mounted
on liquid reservoir, this design operates efficiently with varying liquid levels.

Submerged Mounted,
this type of pump is frequently used on machines requiring mounting in coolant tank.

Shallow Pump
or reservoir use is ideal for this submerged mounted model featuring a sealless design.

ALLIS-CHALMERS

A-5360

DOW CORNING CORPORATION

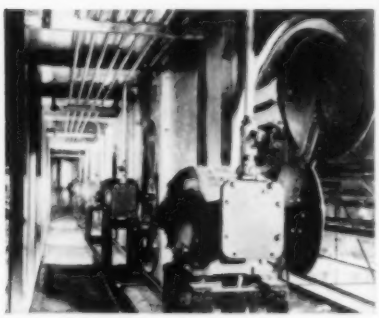
Silicone News

FOR DESIGN ENGINEERS No. 39

Silicone Insulated Motors Provide Dependable Service in Oven Heat

Even the hot, humid, acid atmosphere of a lumber drying kiln won't ruin fan motors insulated with Dow Corning Silicones. Just how tough conditions are for a motor inside a kiln is revealed by Standard Dry Kiln Company, Indianapolis, Indiana.

Not only must Standard's fan motors operate 24 hours a day in ambient temperatures ranging from 200 to 220 F, but they must be able to withstand relative humidity up to 100% and acid atmospheres. No wonder Standard engineers have always been quick to adopt new improvements in motor insulation, and standardized completely on Dow Corning silicone insulation for all Louis Allis fan motors in 1952. (Cont. Pg. 2)



SILASTIC HOSE CARRIES "FURNACE HOT" AIR TO START AIRCRAFT JET ENGINES

Most designers know that jet engines are started by hot air from portable generators. But have you ever given thought to the resilient hose or ducting used to carry the "furnace hot" air from the generator to the engine?

The combination of heat, pressure and rough usage quickly ruins even the strongest metal and fabric hoses. But that's not the case with a new silicone rubber-polyester fiber hose developed by Quaker Rubber of Philadelphia.

Light, tough and flexible, the Quaker hose easily meets rugged service requirements.

TYPICAL PROPERTIES OF SILASTIC FOR HOSE, DUCTS AND TUBING

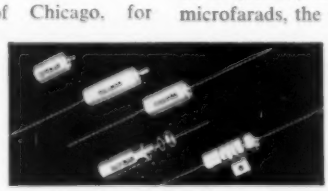
- Temperature range, °F ..... —130 to 500
- Corrosion ..... Non-corrosive to metal
- Pressure range ..... Low pressure
- Oil resistance ..... Dependent on type of oil
- Light Weight • Weather resistant • Flexible

For example, in recent wear tests a typical production hose withstood 65 psi pressure while conveying 125 pounds of 425 F air per minute for 200 hours on a schedule of three hours on and one hour off. The same hose was coiled and uncoiled 300 times at —65 F, then dragged six miles over concrete, macadam and dirt without noticeable wear! (Cont. Pg. 2)

BOOST INSULATION RESISTANCE WITH SILICONE FLUID

Because Dow Corning 200 silicone fluid has better electrical resistance than wax at elevated temperatures, many designers specify this high temperature liquid dielectric to increase the life and reliability of capacitors, small transformers and many other electronic assemblies.

Gudeman Company of Chicago, for example, impregnate their special line of miniature tubular paper capacitors for filter, bypass and blocking service with Dow Corning 200 Fluid.



Only about half as big as comparable conventional units, these silicone-impregnated capacitors are designed to meet all the electrical and environmental requirements for Characteristic "K", MIL-C-25A.

While the insulation resistance of comparable wax-impregnated capacitors at 85 C (185 F) is only about 15 megohm-microfarads, the new silicone fluid impregnated units register 150 megohm-microfarads at the same temperature. That's approximately 10 times the insulating efficiency of conventional units. **No. 396**

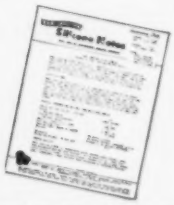
FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

DOW CORNING CORPORATION

Silicone News

DOW CORNING PUBLICATIONS ON NEW DEVELOPMENTS AND TECHNICAL DATA . . . .



Silastic — in mechanical applications — increases life and serviceability of original equipment; reduces maintenance and downtime. A completely new brochure gives properties and cites applications and case histories to help you use this versatile silicone rubber to best advantage in your application. *No. 400*

Solventless Silicone Impregnating Resins now commercially available for electrical and electronic equipment, are free-flowing, can be blended, and have good pot life. On curing, these silicone encapsulating resins set to a solid mass having good electrical and physical properties; and retain such properties that a service life of 10 years at 400 F is indicated. *No. 401*

Silastic 916, the first silicone rubber available that combines high strength with thermal stability, is serviceable from —130 to 500 F, has good electrical properties, and is easy to compound and process. *No. 402*

Silicone Coatings for Paper impart excellent, long lasting release characteristics. Applicable as single or two side coatings to glassine, parchment and kraft, they effectively release such sticky materials as asphalt, raw rubbers, epoxy resins and polyurethane foams even after long time contact. Silicone coated papers are useful in wrapping, and interleaving and in making multi-wall bags, cartons and drums. *No. 403*

"Rubber From Rock," a new color-sound movie, explains how Silastic, the Dow Corning silicone rubber, is manufactured from quartzite. Demonstrates why parts fabricated from Silastic retain rubber-like properties from —130 to over 500 F in a wide variety of military and industrial applications. Also covers uses for Silastic as a dielectric in electronic and electrical equipment. To arrange for a showing of "Rubber From Rock" in your plant, circle ..... *No. 404*

1957 Guide to Dow Corning Silicones is a twelve page, fact-filled reference describing the silicone products of interest to most industries. Containing latest data and information, the new 1957 Guide is designed expressly to help you enjoy the advantages, profits, and savings made possible through imaginative use of these versatile engineering materials. *No. 405*

FOR LASTING BEAUTY AND MAXIMUM PROTECTION AT LOWEST COST . . . USE SILICONE BASED PAINTS

In addition to providing Preway, Inc. of Wisconsin Rapids with a permanently attractive finish for their new line of space heaters, a silicone based paint has solved what could have been a costly design and production problem. Here's how:

When tests on the new Preway heater design revealed that the upper grill often attained a surface temperature of 550 F, it was evident that if coated with an organic finish the grille would have to be raised and the cabinet made larger. Instead of re-designing the cabinet, however, Preway engineers simply switched to a heat and oxidation-resistant silicone paint . . . and the problem was solved.

The silicone finish proved far more durable, as attractive as a conventional enamel and it saved the company the cost of expensive retooling. Furthermore, by keeping the unit compact the silicone finish has helped hold production costs down while saving floor space for the consumer without sacrificing heat output.

Preway also realizes another substantial saving on each unit by applying a silicone-aluminum coating to both sides of the drum-like "heat economizer" inside the heater. By raising the "scaling" temperature of mild steel from 1225 F to 1325 F, the silicone coating permits the use of mild steel in place of stainless . . . an additional saving of $1.59 per unit.

Both of the silicone paints in this application are "Sicon" finishes formulated with Dow Corning Silicones by Midland Industrial Finishes. *No. 397*

SILICONE INSULATED MOTORS *(Cont.)*

By switching to Dow Corning 44 Grease, Standard has also reduced its relubrication schedule for bearings in these motors from once every three months to once every three years.

Still another reduction in costs has been obtained by installing aluminum sheathed motor lead wire covered with Silastic*, the Dow Corning silicone rubber. Not only has the Silastic-insulated cable proved more dependable and maintenance-free than conventional cable, but it costs much less to install and eliminates the need for conduit and fittings.

How does Standard sum up its experience with Dow Corning Silicones after five years? According to J. B. Welch, President, "our experience indicates these motors and their wiring will operate inside the kiln day and night, year 'round without fail." *No. 398*

"HOT AIR" HOSE *(Cont.)*

This rugged new hose is comprised of two inner layers of Silastic*, the Dow Corning silicone rubber, covered with closely woven Dacron. Already a standard accessory for the portable jet "starters," it is now being considered for the hot-air ductwork to operate entire aircraft accessory systems by pneumatics. *No. 399*

*T.M. REG. U.S. PAT. OFF.

Dow Corning Corporation, Dept. 0610, Midland, Michigan
Please send me: 396 397 398 399 400 401 402 403 404 405

NAME _____
TITLE _____
COMPANY _____
STREET _____
CITY _____ ZONE ____ STATE _____

SILICONE NEWS is published for product design and development engineers by

DOW CORNING MIDLAND — *first in silicones* — DOW CORNING SILICONES — CORPORATION MICHIGAN

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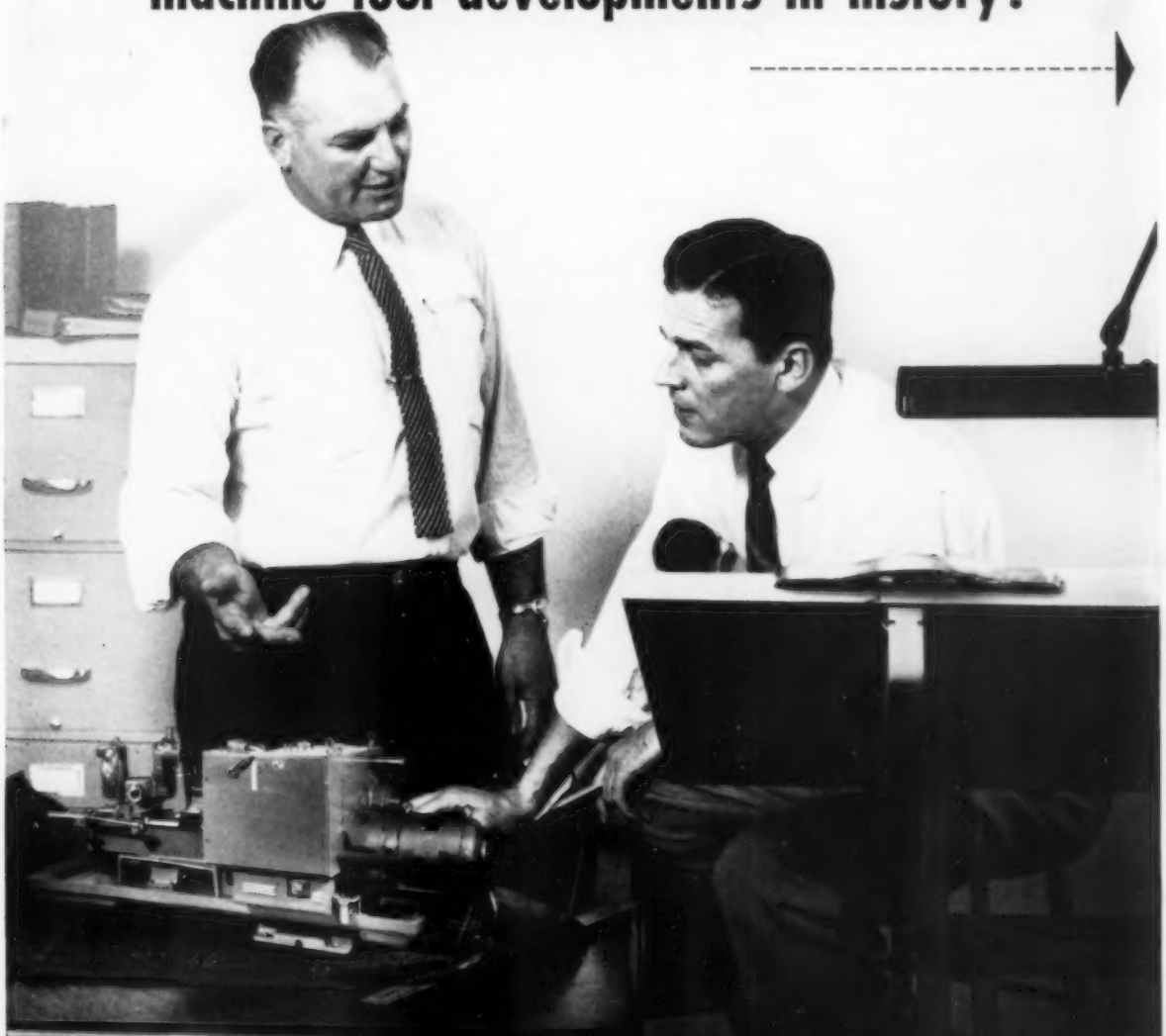
MACHINE TOOL DESIGNERS:

Westinghouse components and services will help you pioneer the greatest machine tool developments in history!



YOU CAN BE SURE... IF IT'S

Westinghouse

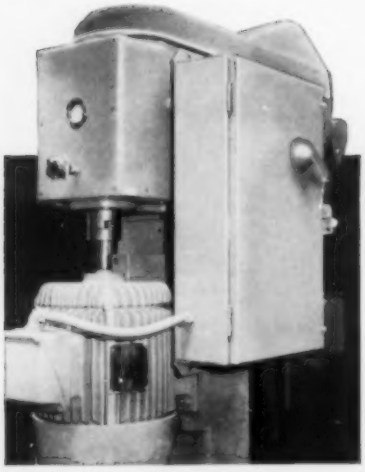
MP-3050-1

CITY _____ ZONE ____ STATE _____

CANADA: DOW CORNING SILICONES LTD., TORONTO GREAT BRITAIN: MIDLAND SILICONES LTD LONDON FRANCE: ST GOBAIN, PARIS

NEW DEVELOPMENTS FROM WESTINGHOUSE . . .

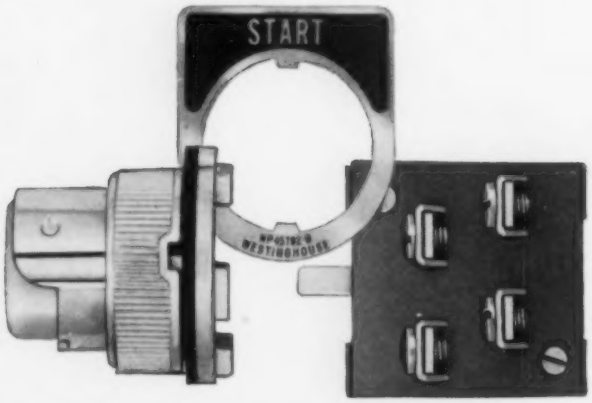
Improve drive and control functions on your new machine tools



Eighty light-load reversals per minute and no overheating . . . with Westinghouse Life-Line® "A" motors. Reliable performance under severe duty cycles lets you plan greater versatility for machine tools.

Cushioned start of connected load is assured by Westinghouse magnetic reduced-voltage starters. Add-A-Part feature provides flexibility for design and future change-over.

Cypak control has no moving parts to wear, corrode or jam. Service life is 15 times that of mechanical relays, maintenance and down time virtually eliminated. Cypak systems are compact, light, easy to modify.



Just 38 Westinghouse Oil-Tite* pushbutton components . . . standardized, interchangeable, always available from stock . . . offer up to 1,500,000 pushbutton control arrangements—cut space, inventory needs. *Trade-Mark

Westinghouse machine tool transformers take one-third less space, exceed NEMA regulation standards by 30%. Add-A-Part fuse blocks and breakers extend design selection, reduce transformer inventories.

The growing trend to faster specialized machine tools with more automatic operation makes design of compact, dependable drive and control systems for your products more vital than ever. Westinghouse has recently contributed many significant electrical developments to machinery builders that promise great strides in machine tool progress.

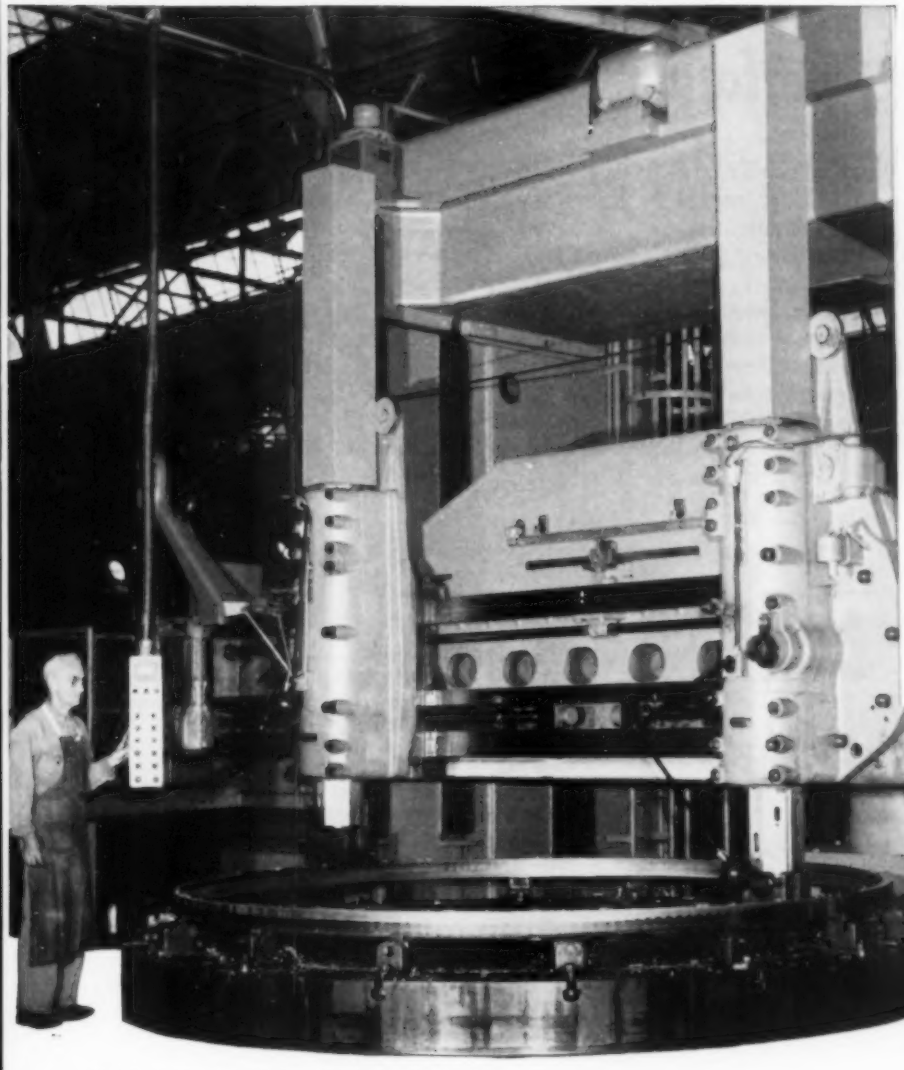
For example, there's Cypak*, a revolutionary development of Westinghouse research for reliable electrical control for machine operations, processes, and coordinated handling of materials. *It has no moving parts* to wear, corrode or jam . . . assuring long life and dependability.

Contactless limit switches, industrial electronic components unsurpassed in performance, improved-design motors, and numerous other product refinements and innovations point to Westinghouse as the electric components supplier for your machine tools.

Developments like these will help you design and build machine tools that better satisfy your customers through increased productivity, reduced inspection and maintenance, and more precise operation. Whatever the function you want performed . . . sensing, transmitting, recording, computing, control, or driving . . . think of Westinghouse components first.

*Trade-Mark
MP-3050-2

YOU CAN BE SURE... IF IT'S Westinghouse



Versatility of Westinghouse AV Drive pays off in applications like this heavy-duty, 14-foot boring mill. Package drive provides on-the-spot conversion of a-c power supply to d-c for precise speed control over a wide, adjustable speed range.

Westinghouse service and facilities back up product performance

Your local Westinghouse representative should be a member of your machine design team. He is trained to give you the full benefit of Westinghouse engineering and development information in analyzing your machinery electrification problems.

Westinghouse facilities are located in industrial centers from coast to coast. Westinghouse research . . . field engineering service . . . local manufacturing and repair plants . . . renewal parts stocks . . . all have been established to benefit you and your customers.

The Machine Tool Electrification Forum, sponsored annually by Westinghouse during the past 21 years, is an example of Westinghouse participation and cooperation with the machine tool industry. New ideas fostered and exchanged at such meetings help speed machine tool advances.

When you specify components, choose Westinghouse and be *sure*. You get one-supplier responsibility for products of outstanding quality, backed by more than 70 years of electrical experience. And, Westinghouse components help sell your products. Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa.

MP-3050-3

Westinghouse serves these O. E. M. industries

- Air conditioning
- Appliance
- Communications—electronic
- Electric apparatus
- Fan and blower
- Machine tool
- Materials handling
- Panelboard and switchboard
- Prime mover equipment
- Pump and compressor
- Miscellaneous machinery

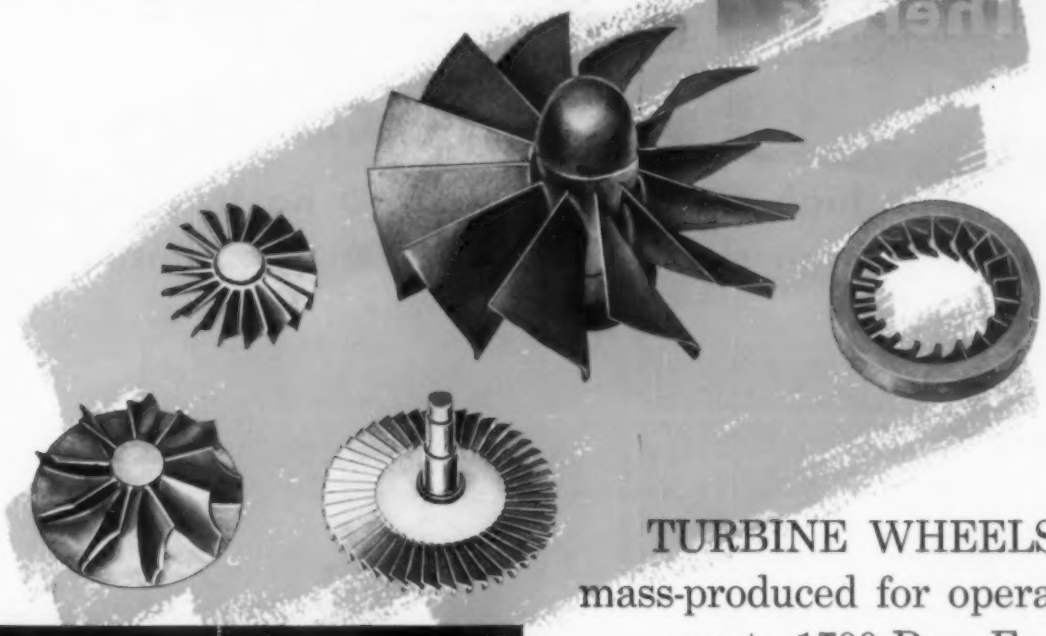
. . . with these components

- Motors—gearmotors
- Adjustable-speed drives
- Gearing
- Controls—relays—circuit breakers
- Semiconductors
- Cypak
- Magamp* magnetic amplifiers—rectifiers
- Heating elements—thermostats
- Transformers
- Instruments
- DYNAC® magnetic braking

*Trade-Mark

YOU CAN BE SURE... IF IT'S Westinghouse

HAYNES investment casting solves the *tough* design problems



TURBINE WHEELS mass-produced for operation up to 1700 Deg. F

Special inspection equipment guarantees accuracy. Examinations by Gamma Ray (above) is one of a number of inspection methods used at Haynes Stellite Company's plant to insure top quality control.

Turbine wheels with intricate blading—some as thin as 0.020 in.—and ranging in diameter from 2 to 21 in. are now mass-produced economically by HAYNES' investment-casting method. The blades and wheel are produced as one integral part to close as-cast tolerances.

HAYNES' investment-casting method offers the design engineer a selection of alloys developed for economical operation over a wide temperature range—from room temperature to 1700 deg. F. The cast wheels have high strength and are capable of operating at speeds in excess of 42,000 revolutions per minute.

The freedom to select alloys for performance and to design for top efficiency is one of the big advantages of HAYNES' investment-casting process. For full details, write for the booklet "HAYNES' Investment-Casting." Address Haynes Stellite Company, Division of Union Carbide Corporation, General Offices and Works, Kokomo, Indiana.

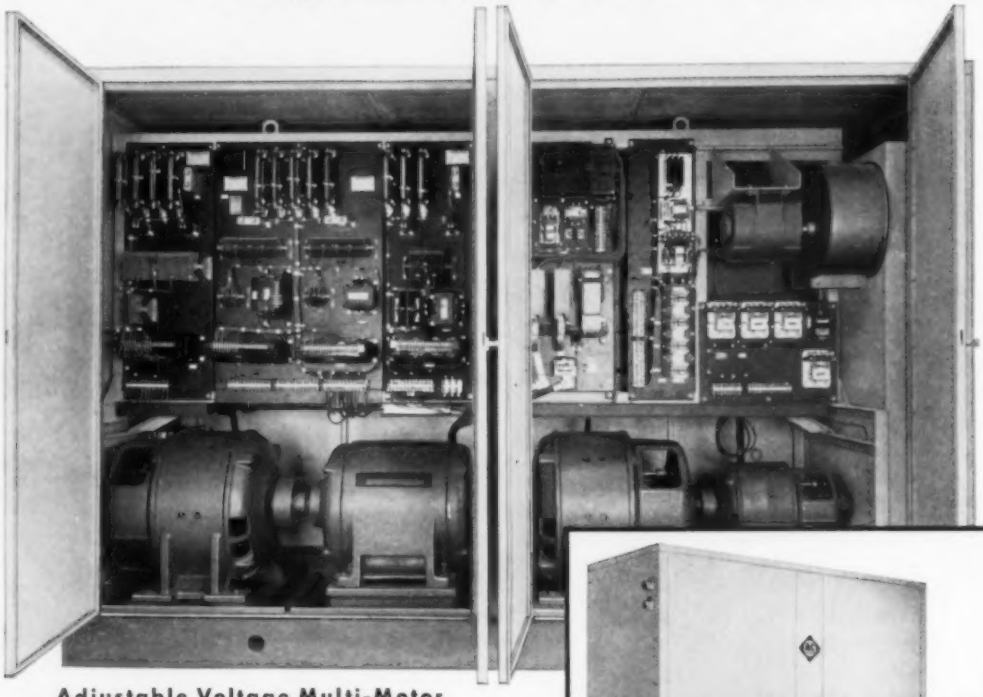
HAYNES
ALLOYS
HAYNES STELLITE COMPANY
Division of Union Carbide Corporation

UNION CARBIDE

"Haynes" and "Union Carbide" are registered trade-marks of Union Carbide Corporation

There's MORE dependable speed control

- high response
- high shock resistance
- no fragile parts
- no maintenance



Adjustable Voltage Multi-Motor Package Drive is ideal for many industrial applications. Self-ventilation keeps unit clean, minimizes maintenance.

Size 3 Adjustable Voltage Power Unit rated 30 hp. of standard construction. Magnetic amplifier excitation provided.

Every one of the design features of the Allis-Chalmers Adjustable Voltage Package Drive assures you an easy, dependable means of power conversion.

Key to Package Drive dependability is the use of a magnetic amplifier to excite the field of the power unit m-g set. Sturdy and simple, this amplifier has no moving parts to wear out . . . no fragile components to be affected by vibrations. AND — there's no wasteful "warm-up" time needed. At the turn of a dial, you get immediate speed control.

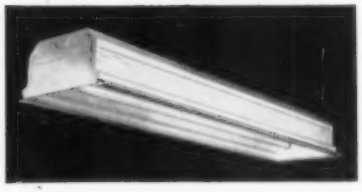
Cost-saving assembly

M-g set and control components are assembled in the power unit enclosure at the factory — saving you installation costs. Enclosures used for 30 through 200-hp units are completely collapsible and may be easily disassembled without loss of rigidity. Larger units have separately driven blowers to provide positive ventilation and pressure even when unit is idle.

Available in units from 5 to 200 hp, the package drive is ideal for any application requiring adjustable speed. Contact your nearby Allis-Chalmers sales office or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS A-5270

MANUFACTURER SHEDS NEW LIGHT ON WEIRZIN® RUST PREVENTION



In the market for a rust-resistant, eye-appealing and economically enduring zinc-coated steel? Then tune in on what the Edwin F. Guth Co., St. Louis, Mo., a leading manufacturer of lighting fixtures, has to say about Weirzin. For example:

RUST PREVENTION: "Weirzin electrolytic zinc-coated steel sheets *assure* our customers of a rustless product regardless of what section of the U.S.A. or hemisphere our Guth fixtures are sold. Whether it's damp, dry, moist or cold, Weirzin sheets once coated with paint really provide a finish that lasts."

PAINT SAVINGS: "There's a decided savings in the amount of paint we use; our finishes seem to grab hold of Weirzin sheets and stay there. Hence, with more positive paint adherence, we use considerably less paint. And, we find our present paint equipment can carry the load without the need for additional equipment."

Chemically treated Weirzin takes a beautiful paint, lacquer, enamel or lithographic ink finish. Holds it better than any other form of steel. Eliminates underfilm corrosion. Weirzin's electrolytic-process zinc coating has the ductility and toughness to withstand the severest fabrication operations. No flaking, peeling; no need for coating or re-coating after fabricating. For specific information on Weirzin in *your* applications, write Weirton Steel Company, Dept. D-15, Weirton, W. Va., for our free illustrated booklet—"Weirzin."

WEIRTON STEEL COMPANY

WEIRTON STEEL COMPANY

WEIRTON, WEST VIRGINIA

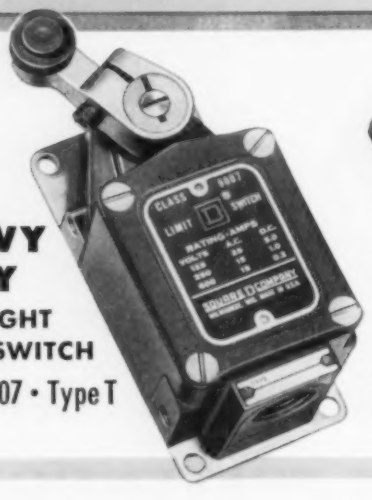
a division of

NATIONAL STEEL CORPORATION

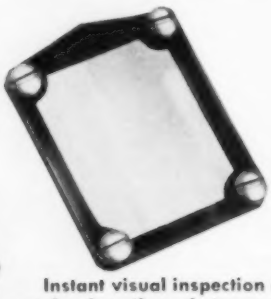
SQUARE D Limit Switches with– Features

–TO THOSE WHO BUILD MACHINES

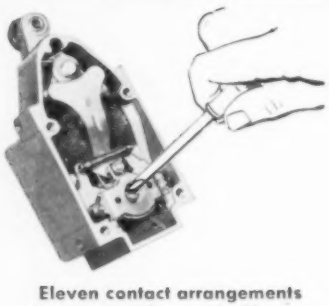
Square D limit switches have certain design features that warm the cockles of any machine builder's heart. You can spot the major ones in the panels below. Equally important is the customer's nod of approval when he sees the time-proven D nameplate on the limit switches that help control his new machine.



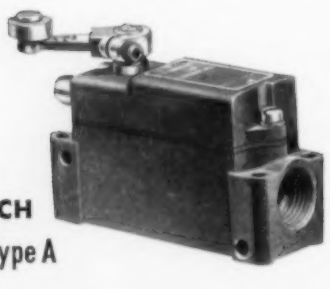
HEAVY DUTY
OIL-TIGHT LIMIT SWITCH
Class 9007 • Type T



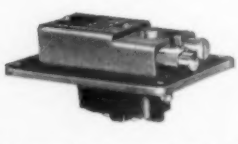
Instant visual inspection of mechanism through transparent plastic cover (optional). A tremendous time saver in multiple switch installations.



Eleven contact arrangements in one switch...and all you need to make the changes is a screwdriver!



SMALL
OIL-TIGHT LIMIT SWITCH
Class 9007 • Type A



This small precision limit switch is available in three forms—basic contact mechanism, flush mounting and surface mounting. Both flush and surface mounting switches are available with varying lengths of roller arms and with rollers of different types and sizes. Also push rod operated *(shown above)* and in single unit or duplex construction.

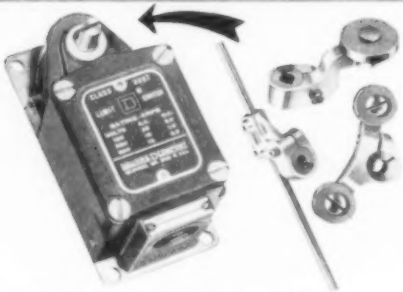
NOW...EC&M PRODUCTS ARE A PART OF THE SQUARE D LINE

SQUARE D COMPANY

that Mean Plenty

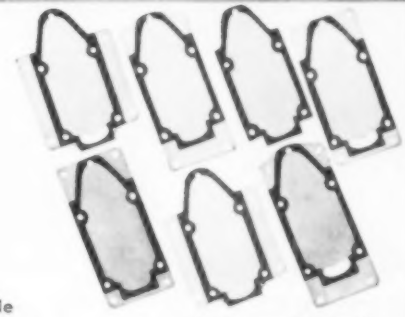
...AND TO THOSE WHO BUY THEM

Just as you'd suspect, it's Square D's consistent performance and long life that appeals most to the men who buy and maintain the machines. But there are other advantages, too, having to do with versatility, easier installation and simpler maintenance. Some of the more important ones are illustrated below.



Simplified stocking because basic switches and a wide variety of lever arms are packaged separately. Moderate stock handles a multitude of combinations.

Continuously adjustable operating lever arms permit an infinite number of adjustments! Up to 80° overtravel reduces arm breakage.

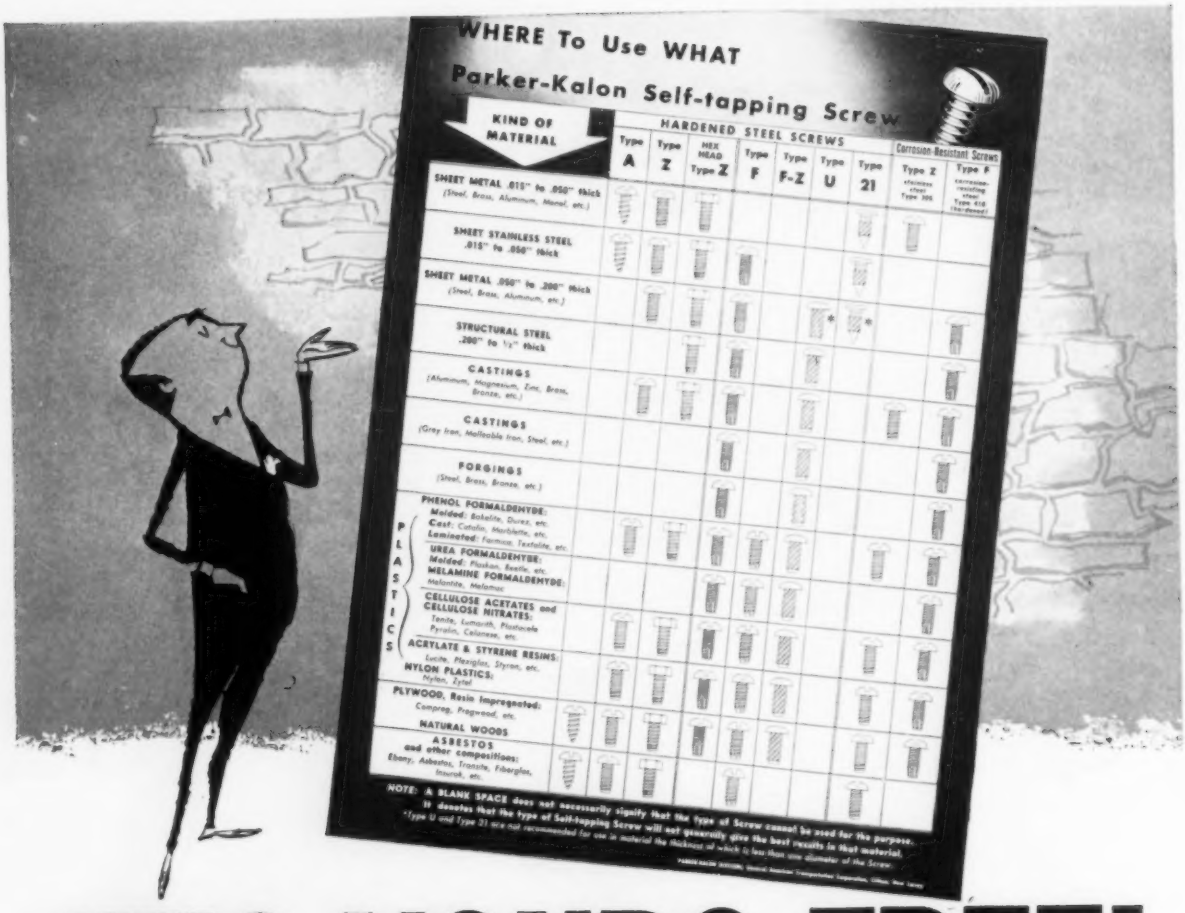


Easy mounting and interchangeability through wide variety of base plates and side mounting holes.

Roller arms are available in a wide range of designs and lengths.

Write **for Bulletin 9007** . . . which gives the details of Square D's complete line of oil-tight limit switches. Address Square D Company, 4041 North Richards Street, Milwaukee 12, Wisconsin.

Everybody's Ahead with Square D!


WHERE To Use WHAT
Parker-Kalon Self-tapping Screw
KIND OF MATERIAL
HARDENED STEEL SCREWS
Type A
Type Z
HEX HEAD Type Z
Type F
Type F-Z
Type U
Type 21
Corrosion-Resistant Screws
Type Z
Type F
SHEET METAL .015" to .050" thick
(Steel, Brass, Aluminum, Monel, etc.)
SHEET STAINLESS STEEL .015" to .050" thick
SHEET METAL .050" to .200" thick
(Steel, Brass, Aluminum, etc.)
STRUCTURAL STEEL .200" to ½" thick
CASTINGS
(Aluminum, Magnesium, Zinc, Brass, Bronze, etc.)
CASTINGS
(Grey Iron, Malleable Iron, Steel, etc.)
FORGINGS
(Steel, Brass, Bronze, etc.)
PLASTICS
PHENOL FORMALDEHYDE:
Molded: Bakelite, Durez, etc.
Cast: Catalin, Marblette, etc.
Laminated: Formica, Textolite, etc.
UREA FORMALDEHYDE:
Molded: Plaskon, Beetle, etc.
MELAMINE FORMALDEHYDE:
Melamine, Melamac
CELLULOSE ACETATES and CELLULOSE NITRATES:
Tenite, Lumarith, Plastacele
Pyralin, Celanese, etc.
ACRYLATE & STYRENE RESINS:
Lucite, Plexiglas, Styron, etc.
NYLON PLASTICS:
Nylon, Zytel
PLYWOOD, Resin Impregnated:
Compreg, Pregwood, etc.
NATURAL WOODS
ASBESTOS and other compositions:
Ebony, Asbestos, Transite, Fiberglas, Insurok, etc.
NOTE: A BLANK SPACE does not necessarily signify that the type of Screw cannot be used for the purpose. It denotes that the type of Self-tapping Screw will not generally give the best results in that material.
*Type U and Type 21 are not recommended for use in material the thickness of which is less than one diameter of the Screw.

IT'S YOURS FREE!

this see-at-a-glance Self-tapping Screw guide

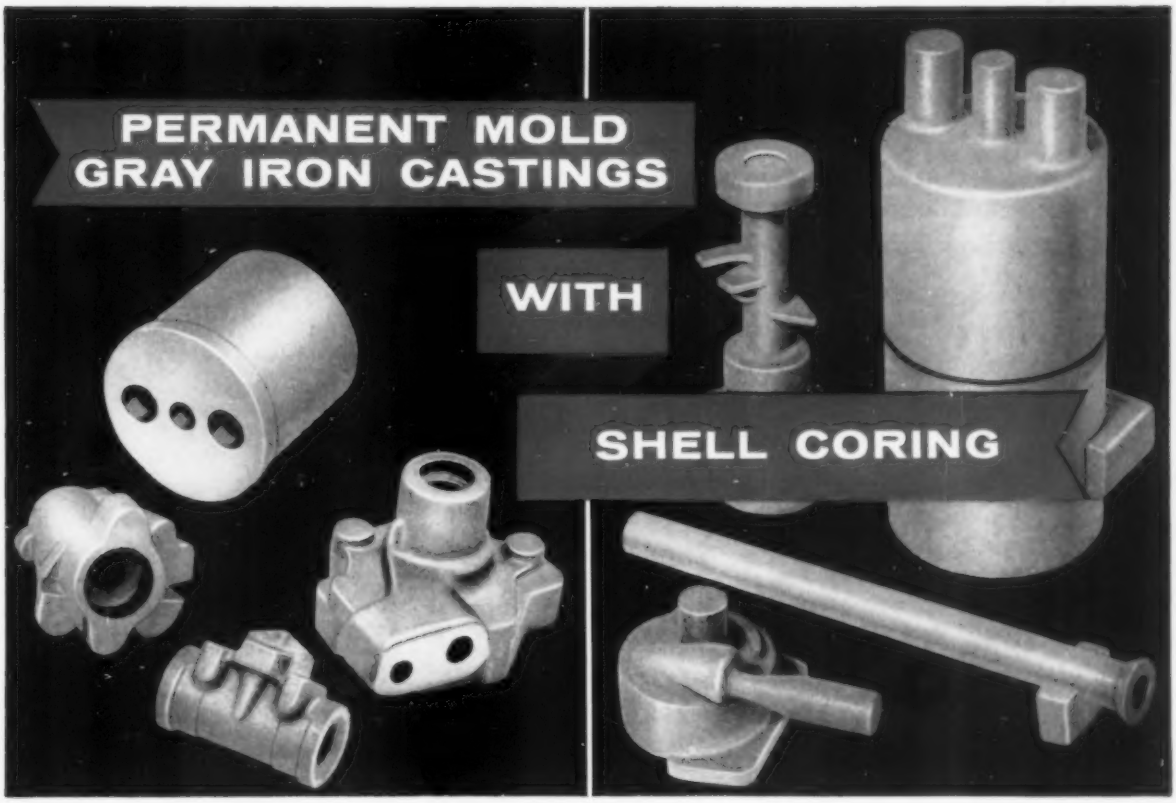
Now . . . you can have this easy-to-read wall chart that instantly shows the proper type of self-tapping screw to use with various thicknesses of metal —with castings or forgings—with plastics—with plywoods, asbestos and other compositions.

Designers and engineers find this chart a handy, time-saving reference. Parker-Kalon, originators of the self-tapping screw, can provide the type you need in the size and head style you require.

For your own copy of this chart, 12½" x 16¾" printed in two colors, simply write to Parker-Kalon on your company letterhead.

PARKER-KALON®
fasteners

***PARKER-KALON DIVISION,** General American Transportation Corporation, Clifton, New Jersey. Manufacturers of Self-tapping Screws, Socket Screws, Screwnails, Masonry Nails, Wing Nuts and Thumb Screws. Sold everywhere through leading Industrial Supply Distributors.*



RESULT: Better Finish at Lower Cost

In addition to the long recognized advantages of Eaton Permanent Mold Gray Iron Castings, the use of shell coring gives an even greater uniformity of structure and an improvement in internal surface finish. This results in machining economy and fewer rejections, which, in the end, mean lower cost of finished parts.

If you have applications where more than ordinary quality is required, Eaton Permanent Mold Gray Iron Castings offer many advantages. Whatever your requirements, our engineers will be happy to work with you.

Send for Illustrated Descriptive Literature

Consider these Important Advantages

- ★ Intricately cored sections
- ★ Uniformity of castings
- ★ Higher machining feeds and speeds
- ★ Substantially increased tool life
- ★ Dense, non-porous, homogeneous structure
- ★ Freedom from inclusions
- ★ Excellent tensile strength
- ★ Ability to take high surface finishes
- ★ Freedom from leakage under pressure

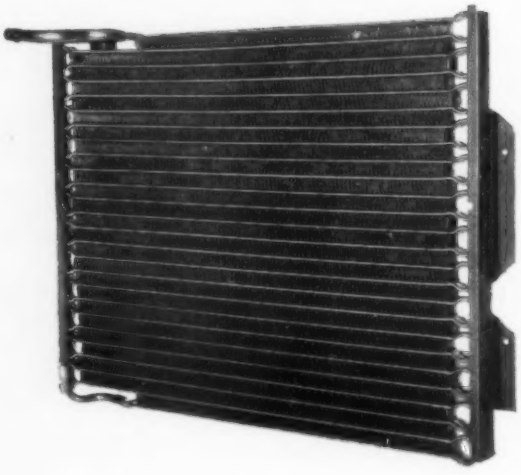
EATON®

EATON FOUNDRY DIVISION
MANUFACTURING COMPANY
VASSAR, MICHIGAN

Hot and bothered by tubing problems?

NEW GM STEEL TUBING "FLATTENED SERPENTINE" HELPS HARRISON COOL AIR BY THE CARLOAD

New Harrison Air Conditioning Systems for the '57 GM line use new "flattened serpentine" condensers of GM Steel Tubing. This exclusive development provides more contact area for a better bond, lets less tubing handle a higher heat-transfer volume . . . cuts size and weight, boosts efficiency and strength. It's another GM Steel Tubing "first"... and typical of the resourceful engineering service that's ready to go to work on *your* product problems. Check Sweet's Product Design File 1a/Ro, write us direct or call your Rochester Products Sales Engineer.



GM STEEL TUBING BY ROCHESTER PRODUCTS

ROCHESTER
PRODUCTS
DIVISION OF
GENERAL MOTORS
ROCHESTER N.Y.

COMPACT . . . POWER-PACKED TRI 55 CLAD MOTORS

Plan now to use G-E TRI 55 CLAD motors in ratings to 125-hp

REG U.S. PAT OFF

Increased production throughout U.S. industry has created a demand for more powerful machines with greater speeds and increased capacity. To meet this demand, General Electric will soon announce a wider range of Tri-Clad '55' motors in compact . . . power-packed dimensions.

ADVANCE INFORMATION—Experienced engineers and skilled craftsmen have utilized revolutionary new materials and the most modern production techniques to pack more power into these larger G-E motors built to new NEMA standards. The more rugged, higher horsepower motors will feature easy installation, reduced maintenance, and long-life performance.

PLAN AHEAD—New Tri-Clad '55' motors can mean real savings in your plant modernization project and in new product design. For complete details on the wider range of motors, contact your nearest General Electric Apparatus Sales Office. For advance size information, send in the attached coupon for free slide rule. General Electric Company, Schenectady 5, New York.

Progress Is Our Most Important Product

GENERAL ELECTRIC

FREE SLIDE RULE

ADVANCE INFORMATION TO HELP YOU PLAN AHEAD

FREE SLIDE RULE—Write for free slide rule which lets you determine at a glance the weight and space-saving benefits of new Tri-Clad '55' motors up to 125-hp. This handy slide rule provides advance information to solve your design problems . . . to benefit your over-all operation.

SECTION B891-2

GENERAL ELECTRIC COMPANY

SCHENECTADY 5, NEW YORK

I would like advance information on new dimensions of Tri-Clad '55' motors up to 125-hp. Please send me free slide rule.

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

CITY & STATE_____

Latin Square, Univac and 36 years experience

all three help assure National Seals are best engineered

Univac you know, experience you know; the Latin Square? An ancient, half-forgotten solver of problems having many variables. Today, National Seal engineers use it to reduce exploratory engineering time as much as 75%.

Old, new, time-tested and visionary—National Seal engineers embrace every approach that can help keep National Seals the best engineered in America. Results have been good. Syntech®, the milestone in synthetic rubber seals and Micro-Torc®, major forward step in leather seals, are but two examples.

National Seal's advanced engineering, in plant or field, is ready now to help you solve sealing problems. This help is yours for a telephone call.

VITAL: Whatever seals you buy, save trouble and expense later on by specifying them "on the board." For safety, have specifications checked by a National Seal engineer.

NATIONAL SEAL Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California; Plants: Van Wert, Ohio, Redwood City and Downey, California

36th Year

National Field Engineers At Your Service: Chicago, Ill., Room 462, McCormick Building, HArrison 7-5163 • Cleveland, Ohio, 210 Heights Rockefeller Bldg., YEllowstone 2-2720
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4228

Another Goodyear First:

V-Belts

with the Green Seal

stay matched from factory to drive

The Green Seal signifies true dimensional stability. It means that now when you reach for a matched set of V-belts, you can be sure they're matched – no matter how long they've lain on the shelf. And that means longer life and a minimum of down time.

It used to be that only steel-cable V-belts by Goodyear were length stabilized. But now, through the miracle of Triple-Tempering, they've been joined by all the other Goodyear Industrial V-belts.

Triple-Tempering is the exclusive process wherein synthetic cord is carefully brought to the peak of strength and stability by controlled tempering with Tension, Temperature and Time. And this gives you not only *length* stability in storage, but greater shock- and stretch-resistance on the drive.

In addition to 3-T load-carrying members, the Green Seal also brings you "balanced construction." This means each component of the belt is specifically designed to its job to give you cleaner, smoother, longer running which adds up to maximum, trouble-free horsepower hours at minimum cost.

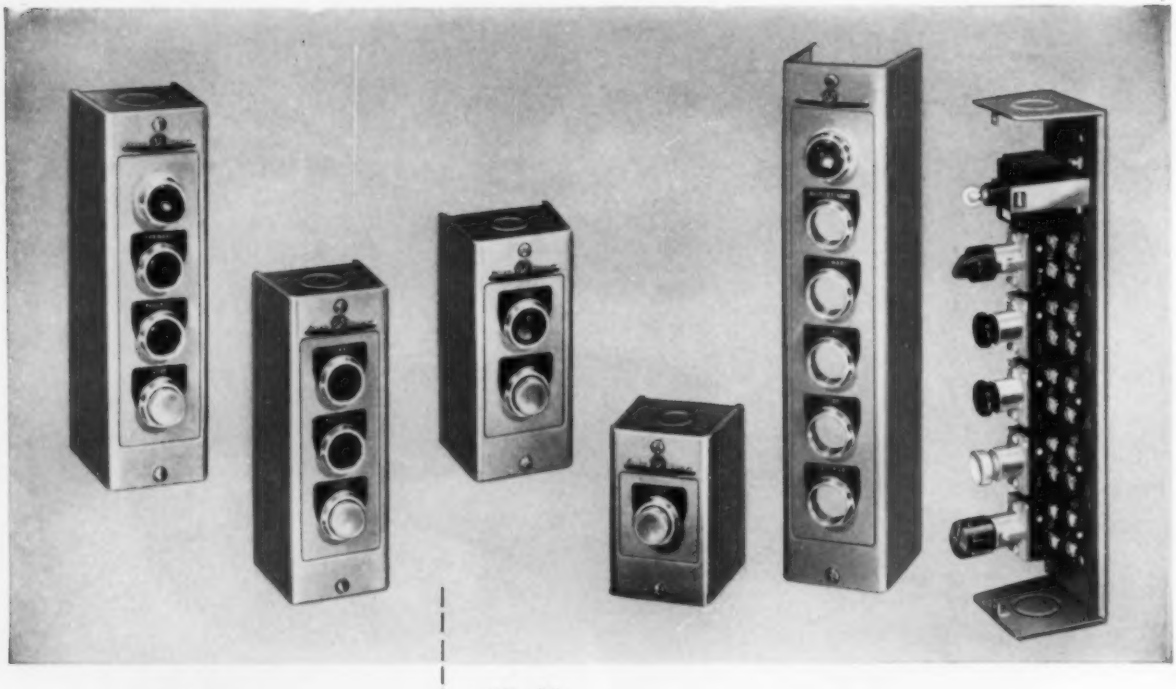
The next time you need V-belts, be sure they're wearing the Green Seal–the mark of a V-belt made with the technical know-how of the world's largest rubber company. They're readily available at your Goodyear Distributor. Or write for details to Goodyear, Industrial Products Division, Lincoln 2, Nebraska, or Akron 16, Ohio.

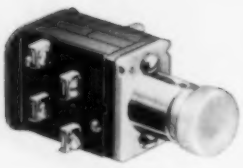
DIMENSIONALLY STABLE V-BELTS by

GOODYEAR

THE GREATEST NAME IN RUBBER

Green Seal–T. M. The Goodyear Tire & Rubber Company, Akron, Ohio





Various types of operators are available, such as standard head, mushroom head, coin slot, key type, wing lever, and 2 or 3-position selector switches. Buttons can be had in a variety of colors.

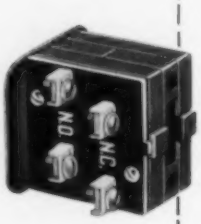
New HEAVY-DUTY PUSH BUTTONS

These new Bulletin 800 heavy-duty push buttons are the modernized version of the old, reliable line of Allen-Bradley heavy-duty stations. Advantages which . . . until now . . . have been restricted to oiltight stations used for machine tool service . . . have all been built into these new, heavy-duty stations . . . and *you* benefit from the result.

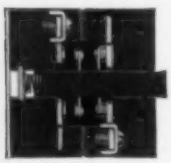
For instance, each button, selector switch, or pilot light is a self-contained unit which can be mounted singly or in groups—vertically or horizontally—in a variety of standard Allen-Bradley enclosures, or any other enclosure arranged for these units. The name plate reading will always be in the right direction. Double break, silver alloy contacts are used throughout.

No matter how special the station may be, it can be assembled on the job from a small stock of standard units. Standard enclosures accommodate up to 8 units. Enclosures for more than 8 units can be supplied on special order.

Please write for descriptive Bulletin 800.



External view of the contact block, showing the normally open and normally closed contact terminals.



Internal view of contact block, showing stationary, double break N.O. and N.C. contacts. The push rod carries the moving contacts.

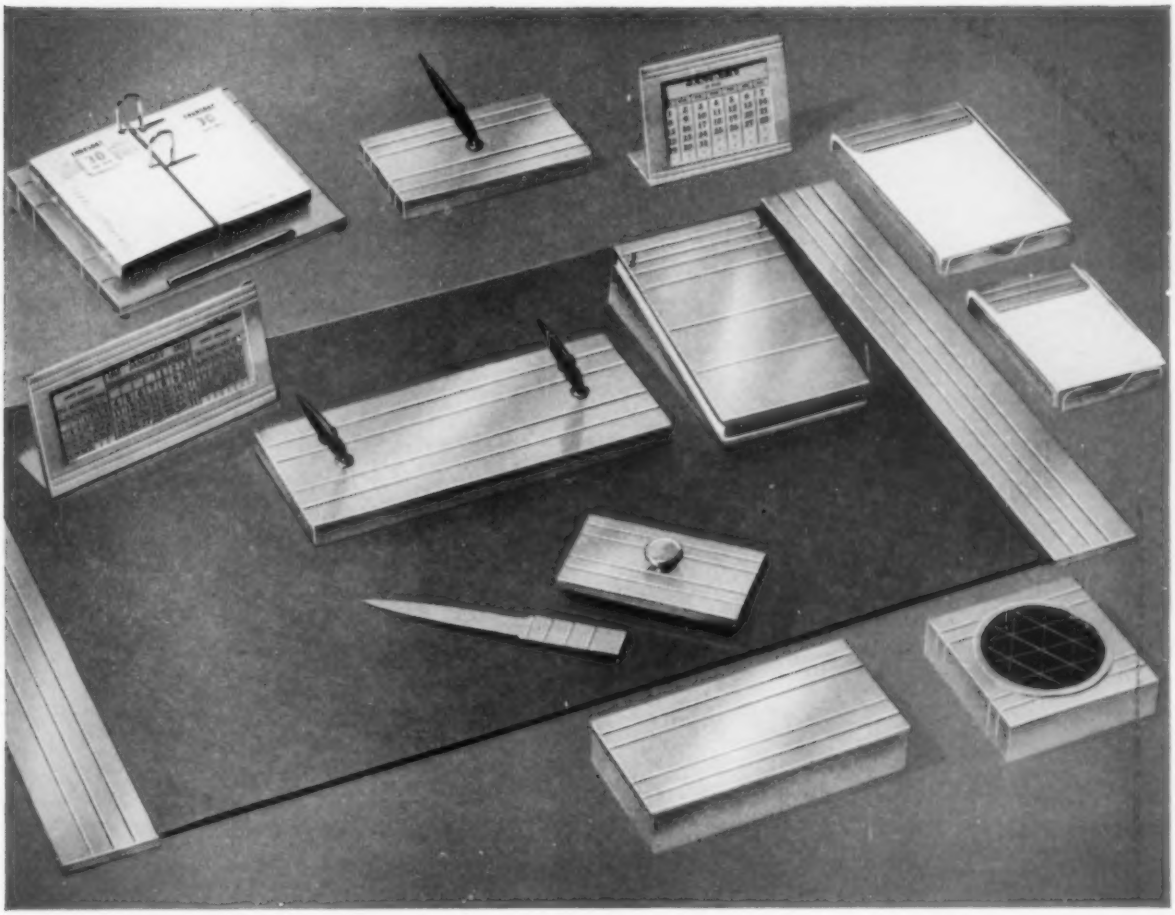
A-B Quality

THE SIGN OF
QUALITY
MOTOR CONTROL

Allen-Bradley Co.
1329 S. Second St.
Milwaukee 4, Wis.

In Canada—
Allen-Bradley Canada Ltd.
Galt, Ont.

ALLEN-BRADLEY
SOLENOID MOTOR CONTROL
QUALITY



A few of the fine executive desk appointments made of Formbrite by Smith Metal Arts Co., Inc.

For a superfine luster that lasts—superfine-grain Formbrite

Smith Metal Arts Co. uses easy-to-polish, scratch-resistant Formbrite to add value to its line of distinguished desk appointments.

The fine executive desk appointments made by Smith Metal Arts Co., Inc., Buffalo, N. Y., are not just polished to shine. They are brought up to a beautiful deep luster. For their line of brass accessories they use Formbrite,® Anaconda's superfine-grain drawing brass.

They have found that the fine, uniform grain size of Formbrite enables them to give their pieces a superior, more uniform texture. The luster, furthermore, stands up better under handling because Formbrite provides a harder, more scratch-resistant surface.

In order to achieve this fine luster, Smith Metal Arts Co. must do an exceptional amount of polishing and they have chosen Formbrite because of its superior polishing characteristics. By using Formbrite they can achieve their high quality surfaces at savings of 20% over the use of ordinary brass.

See for yourself. Formbrite is a premium product at a nonpremium price. Find out for yourself how its superfine grain, excellent drawing properties, strength, and scratch resistance can help you improve product quality, lower finishing costs. Write for Publication B-39. Better yet, ask for a sample or details on our trial order offer. Address: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

5773

Formbrite
SUPERFINE-GRAIN DRAWING BRASS
an ANACONDA® product
Made by The American Brass Company

Great advances in design . . .

NEED THE ADVANCEMENT IN WEAR RESISTANCE PROVIDED BY FLAME-PLATING BY LINDE

Lockheed's F-104A Starfighter, newest weapon of the Air Force, is the most advanced airplane of its type. To give them the greatest possible resistance to extreme conditions, bearing surfaces *(arrows)* of hot air valves used in a bleed air system of the F-104A are Flame-Plated with tungsten carbide. Flame-Plating provides the wear-resistant coating needed to withstand the high unit loading and temperature extremes jet plane parts undergo.

Stratospheric altitudes . . . supersonic speeds . . . extreme temperatures subject jet plane parts to almost incredible conditions of heat and abrasion. To assure perfect operation in all circumstances, bearings of hot air valves in the Starfighter are Flame-Plated. A tungsten carbide coating, applied by LINDE's unique method, is the only material tried that successfully eliminated galling and provided a low coefficient of friction over the required service life of the part. With the part Flame-Plated, practically no wear occurred. This LINDE process is now a regular production procedure.

Flame-Plating is LINDE's special process for protecting metal parts from wear, abrasion, and fretting corrosion. Tiny particles of tungsten carbide or aluminum oxide are literally *blasted* onto the metal surface. Since the temperature of the part being coated seldom exceeds 400 degrees F., there is little or no risk of changes in its shape or metallurgical properties. Flame-Plated coatings can be applied from .002 to .010 inches thick, and used as coated or finished to 0.5 microinches rms. Practically all metals can be Flame-Plated—aluminum, magnesium, molybdenum, titanium as well as copper and steel.

Your own design may be improved by Flame-Plating. Find out how, by writing for a copy of the booklet "Flame-Plating," F8065. Address Flame-Plating, Dept. P-6, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.
In Canada: Linde Company, Division of Union Carbide Canada Limited.

Linde
TRADE-MARK
UNION CARBIDE

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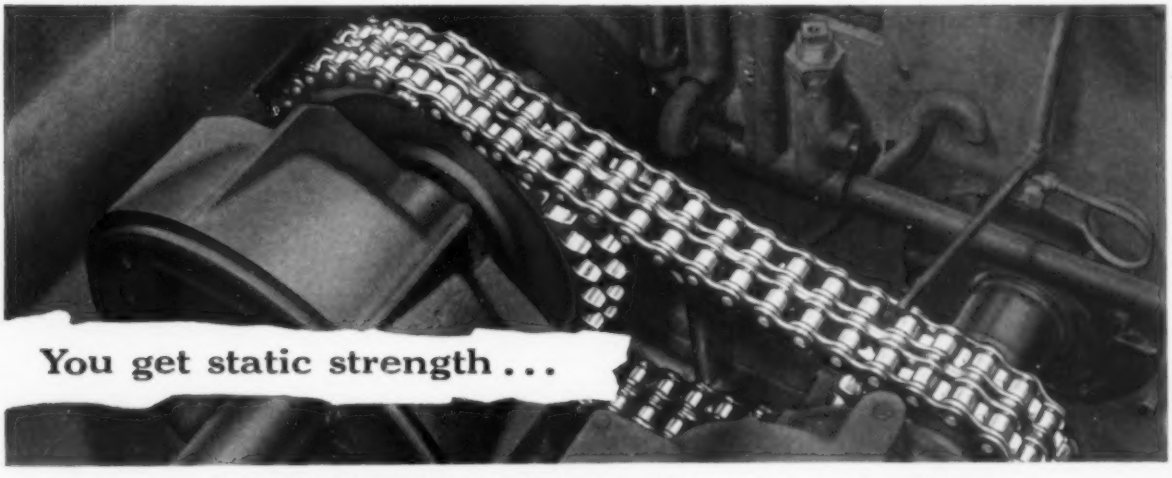
Why tough-service drive and conveyor jobs demand LINK-BELT roller chain



RESISTANCE TO TENSILE STRESS is achieved with properly heat-treated, accurately machined side bars made of premium steel and fitted with properly hardened pins, bushings, rollers.

STRENGTH OF CHAIN IN MOTION results from such refinements as pitch-hole preparation, micro-finish of parts, special processing of side bars, pre-lubrication, rigid quality control.

THE *greater dynamic strength* found in Link-Belt precision steel roller chain is essential for long life on today's harder-working drives and conveyors. This added capacity to resist shock loads, centrifugal loads and similar stresses is achieved only because Link-Belt adds refinements in manufacture.

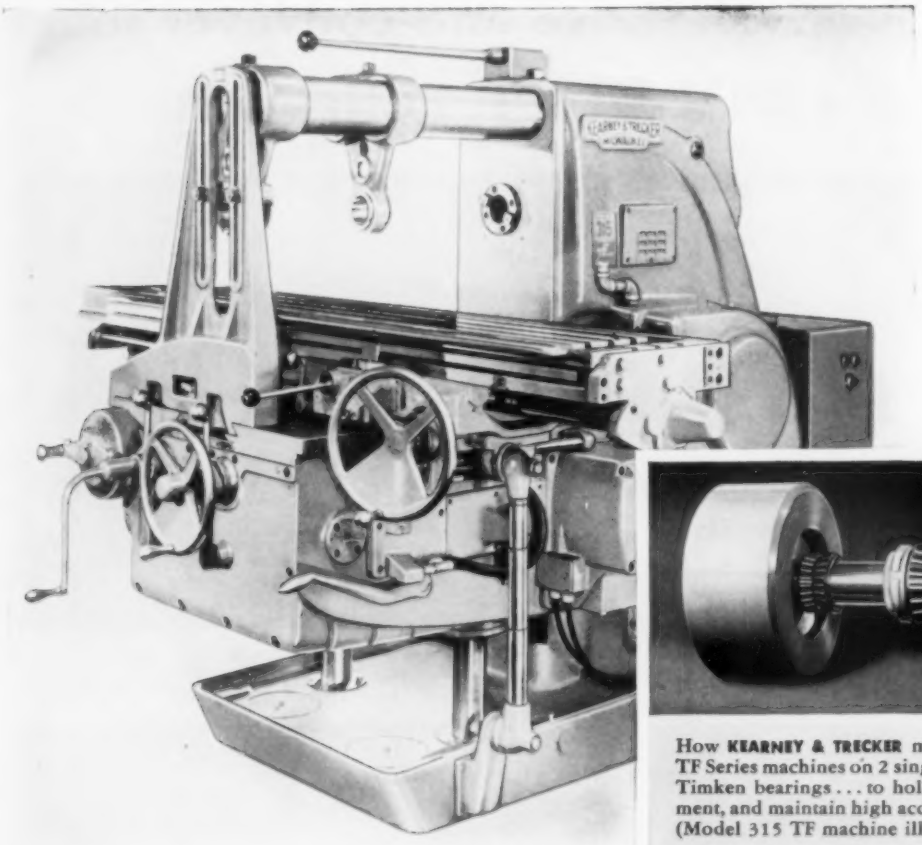
These include lock-type bushings, shot-peened rollers, pre-stressing, closer heat-treat control. The result: a precision chain that takes stresses in stride . . . provides smoother, more efficient performance that measurably outlasts ordinary roller chain — reduces costs.

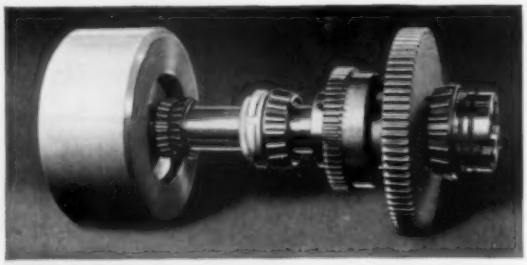
For full data on Link-Belt roller chain and engineering application assistance get in touch with your nearby Link-Belt office.

LINK-BELT

ROLLER CHAIN & SPROCKETS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World. 14.472-A





How **KEARNEY & TRECKER** mounts the spindle of its TF Series machines on 2 single-row and 1 double-row Timken bearings . . . to hold spindle in rigid alignment, and maintain high accuracy through 24 speeds. (Model 315 TF machine illustrated).

New milling machine gets constant accuracy through 24 speeds with spindle on TIMKEN® bearings

FROM 15 to 1500 rpm, with 24 speed changes in all, and plenty of capacity for any tool load—that's the new TF Series of twin-screw designed Kearney & Trecker mills. There are 28 Timken® bearings contributing to these machines' built-in stamina and constant high precision. Most importantly, the spindle is mounted on two single-row and one double-row Timken precision bearings which hold it in rigid alignment through all speed and load changes. Chatter is eliminated, and long bearing life with minimum maintenance is assured.

Because of their tapered design, Timken bearings take radial and thrust loads in any combination. Full line contact between rollers and races imparts extra load-carrying capacity. And of course, with Timken bearings designed to last as long as the machine itself, maintenance costs go down.

Geometrically designed to give true rolling motion, Timken bearings are precision manufactured to live up to their design—produced under rigid inspection and quality control. We even make our own fine alloy steel, something done by no other American bearing manufacturer. When you build or buy equipment, look for the "TIMKEN" trade-mark on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

TIMKEN TAPERED ROLLER BEARINGS ROLL THE LOAD

TRADE-MARK REG. U. S. PAT. OFF.

HOW THE SILICONES MAN HELPED...

Light up the life of a double-decked commuter

Greater comfort for commuters . . . and increased efficiency for railroads in these double decked coaches now in service on the Chicago and North Western Railroad. Brighter, roomier, air conditioned . . . and passenger capacity more than doubled. Problem? Greatly increased power demand but no more space for motor generating equipment. Solution? Class H insulation with Silicones.

The engineering staffs of Waukesha Motor Company and Harnischfeger Corporation, cooperating with the C&NW, designed and built a Class H generator using UNION CARBIDE Silicones as the insulating resin. Silicones stand up under temperatures and loads that break down other insulating materials. The result is a unit no larger than those previously used, but supplying sufficient power to meet the new demands *plus* any overload condition.

This is another example of how the UNION CARBIDE Silicones Man has helped solve an "impossible" problem. To obtain more information on the many advantages of silicone insulation, a booklet—"Class H Insulation with UNION CARBIDE Silicones" is available by writing to Dept. P-6, Silicones Division, Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

UNION CARBIDE TRADE-MARK SILICONES

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In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario.

USS MAN-TEN Steel-the low cost

Meets high formability requirements —saves 24% weight

Here's a job that may surprise quite a few steel users accustomed to thinking of high strength steel as being "stiff" and therefore not readily formable. For in making these LP-gas containers, USS MAN-TEN Steel blanks ¼" thick are press-formed *cold* into seamless shells, 29" in diameter and 24" deep. Such an operation calls for a degree of formability that would be considered high even for carbon steel.

By taking advantage of this property, Pressed Steel Tank Co., Milwaukee, Wisc., was able to reduce the shell thickness of this Hackney container 24%, and at no increase in cost, produce a stronger, tougher and more durable container that is 102 lbs. lighter than when made of carbon steel. This saving in weight means easier handling in the shop and during installation, plus substantial savings in freight costs—both on the steel used and when finished containers are shipped.

Assures greater portability, prolongs life

In portable oil drilling rigs like this, every pound of weight saved is of vital importance. To keep weight as low as possible without sacrificing ruggedness, the Cardwell Mfg. Co., of Wichita, Kansas, has built the trailer frame and working platform of USS MAN-TEN Steel and reduced weight 6,000 lbs. as compared to structural carbon steel construction. In the 96-foot mast, which can be telescoped and folded down when the rig is moved, MAN-TEN Steel used in all the structural members reduces weight about 25%, and helps to keep moving costs down to a minimum. MAN-TEN Steel's superior strength and abrasion resistance, plus its high fatigue strength, also pay off by keeping the rig steadily on the job.

UNITED STATES STEEL
USS
HIGH STRENGTH STEELS
1933 1957
24 YEARS OF PERFORMANCE

USS MAN-TEN Steel–the low cost way to build better performance into equipment like this

IN THE PAST 24 YEARS, USS MAN-TEN Steel has earned the high regard of design engineers–and for good reason.

Faced with the knotty problem of improving equipment, while at the same time keeping down its cost, they have found that with USS MAN-TEN Steel they not only could materially reduce weight–or greatly increase strength and durability–but often could do so at *lower* cost than with structural carbon steel.

For USS MAN-TEN Steel, although it costs only about 25% more, has a yield point at least one and one half times that of structural carbon steel. It has greater abrasion resistance. Its fatigue strength is about 40% higher. Its resistance to atmospheric corrosion is twice that of carbon steel. In addition, USS MAN-TEN Steel is more readily worked and welded than structural carbon steel of the same strength level.

Thus when MAN-TEN Steel is used in the same thickness as structural carbon steel, it will increase strength 50% at only about 25% increase in material cost. And when used in 20 to 25% thinner sections, MAN-TEN Steel construction, though lighter, may be designed for *both* greater strength and lower cost.

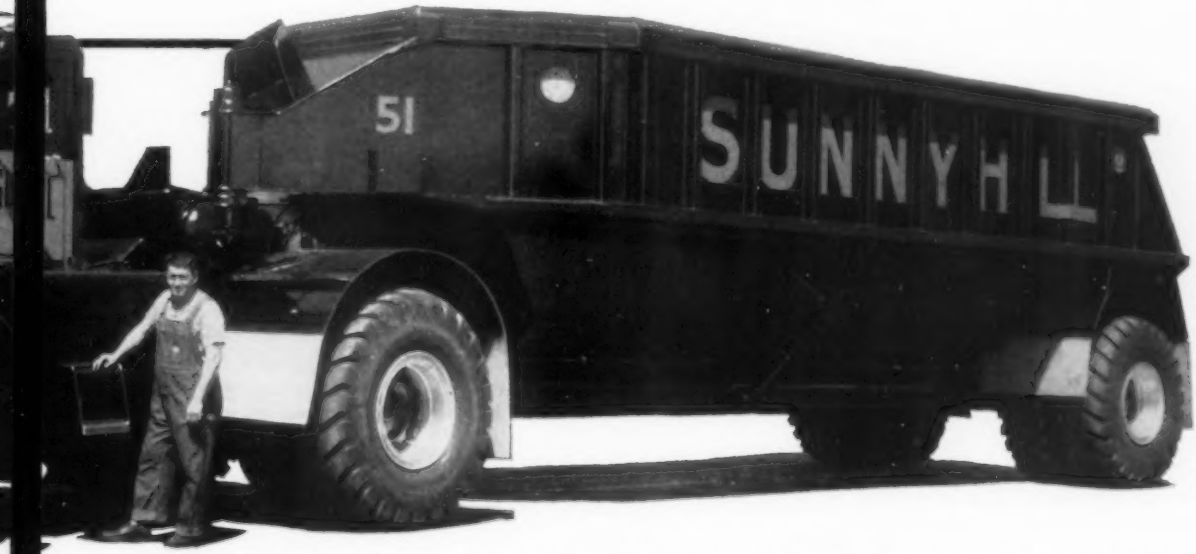
The increased working capacity, longer life and greater freedom from maintenance its use ensures are money-saving advantages that pay off BIG in customer satisfaction and increased salability.

To find out how you can incorporate USS MAN-TEN High Strength Steel in your designs most efficiently and economically, send for our 174-page "Design Manual for High Strength Steels." This authoritative book covers every facet of this important subject. For your free copy, write – *on your company letterhead,* giving your title or department–to United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

Cuts weight 15%, increases payload capacity 15%

This 50-ton Dart coal hauler is a classic example of how USS MAN-TEN Steel can solve a difficult weight problem. Large trucks like this are generally designed right up to the limit of tire capacity. In other words, their size is largely determined by the maximum combined weight of truck and payload that the tires can safely carry. Thus the 15% reduction in body weight made possible by lighter MAN-TEN Steel construction, by lifting that much weight off the tires, enabled the designers to increase the payload capacity by a highly desirable 15% so that the truck is able to carry a huge 50-ton load on rough, off-road hauls without undue jeopardy to tire life.

Ten trucks like this, built by Dart Truck Company, Kansas City, Kansas, have been in use more than three years at Sunnyhill Coal Company's New Lexington, Ohio, workings. Each hauls an average 120,468 tons per year. To date, none has required repair of any kind. All are still in perfect condition.



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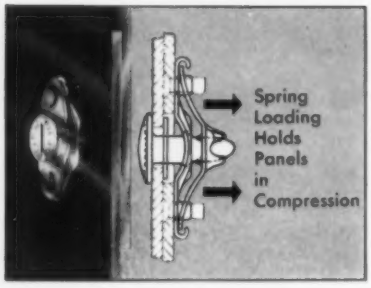
UNITED STATES STEEL

Quick-Opening Fasteners

Selecting Small Fastenings for Metal Closures

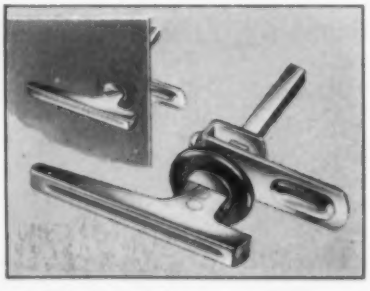
*"Use captive fasteners wherever feasible . . . Avoid the use of loose washers and loose nuts . . . Fasteners on equipment covers should be operable either with no tools or with standard hand tools"**

(John D. Folley, Jr. & James W. Altman, Research Scientists, American Institute for Research)



Quarter-Turn Fastener

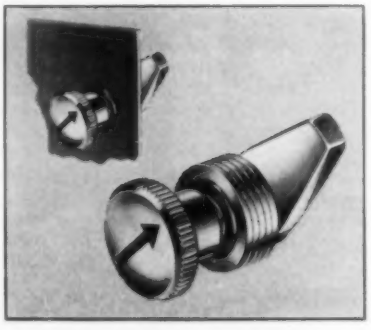
Lion Fasteners open and close with a ¼ turn, hold sheets tightly under the compression of a rugged spring. Quickly operated and fully retained in the outer panel, they are approved under U. S. Government military specifications. Stud and receptacle float for easy alignment and simplified hole preparation. Flush, oval, wing, knurled, ring, and key head styles available. Sizes—No. 2, No. 5, and High Strength for extra heavy duty.



Cabinet Latch

Just drill a hole, push the fastener stem through, and slide the special push-on clip into place. No welds, screws, bolts or rivets: the fastener is permanently installed in seconds!

Adjustable to any grip length or panel thickness, the pawl is fixed in place by a single set screw. The fastener's brightly finished knob is set off by a plated washer. Also furnished with screwdriver operated flush head.

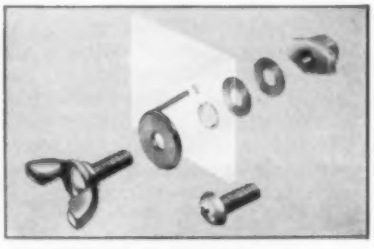


Spring Tension Latch

For fastening slide-out drawers and hinged panels the Southco Arrowhead Latch is recommended. It locks or opens with a quarter turn yet occupies less than ½" inside space.

Doors are held under spring tension—a push against the arrowhead knob relaxes this tension, allows operation with fingertip ease. Drill a single hole for installation—no fastening to the door is necessary. No striker plate is needed.

Pawl stop is eliminated—arrowhead shows at a glance exact position of pawl.



Adjustable Panel Latch

Small doors and panels can be fastened with greatest speed and lowest cost with the Southco Adjustable Latch.

The entire fastener is quickly installed through two holes punched in the door; no bolts or rivets are needed.

It operates with a quarter turn, requires no striker plate. An extra twist after the nylon pawl is engaged pulls up the door to form a seal and eliminate vibration.

Available with wing, knurled, or Phillips head.

Free Fastener Handbook

Send for your free copy of Fastener Handbook No. 7, just released. Gives complete engineering data on these and many other special fasteners. Fifty-two pages, in two colors.

Write on your letterhead to Southco Division, South Chester Corporation, 236 Industrial Highway, Lester, Pa.

SOUTHCO FASTENERS
LION

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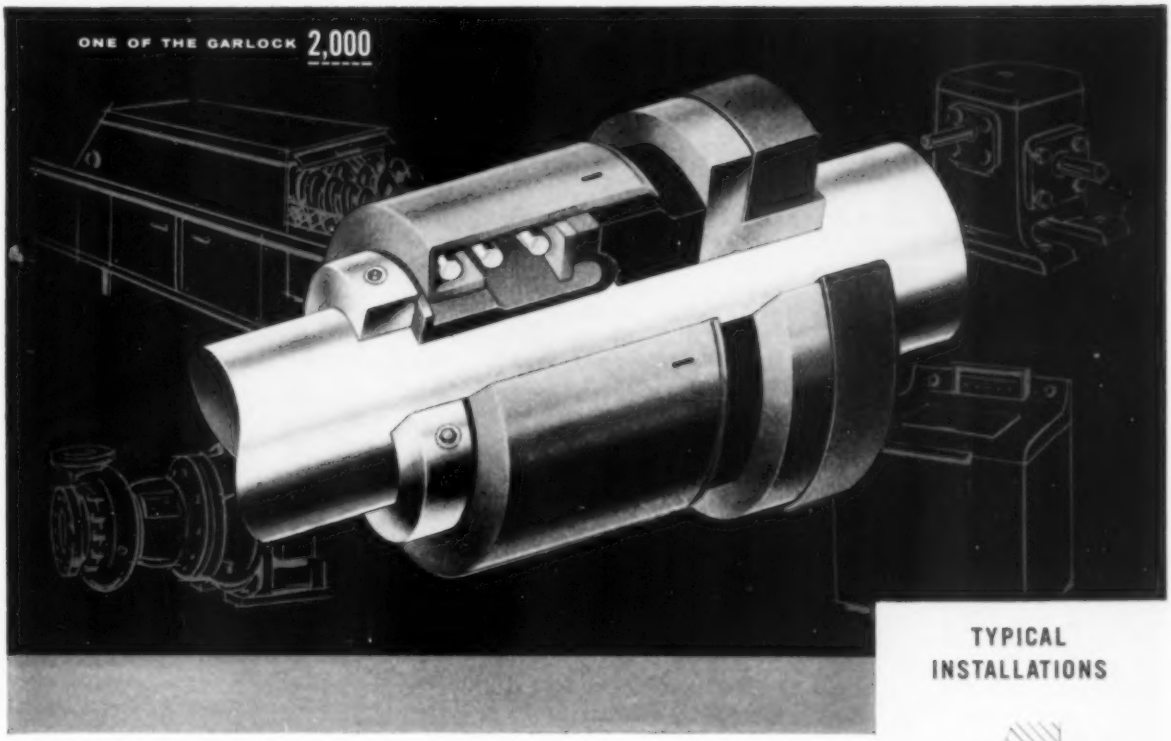
* *Quotation from "Designing Electronic Equipment for Maintainability"; Machine Design, July 12, 1956.*

New trends and developments



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of a hundred uses

This Garlock MECHANIPAK* Seal BB-21A has proved itself on hundreds of jobs, sealing against water, oils, alcohol, mild acids, and solvents. It's ideal for shafts on centrifugal pumps, automatic washers, speed reducers, commercial dishwashers . . . wherever pressures do not exceed 150 psi.

Withstands temperatures to 212° F. with standard bellows or up to 400° F. with silicone rubber bellows . . . shaft speeds to 2000 fpm and higher depending on operating conditions. Sizes for ⅜" to 3" dia. shafts. Mechanical drive arrangement is engineered to eliminate slippage and simplify installation.

The BB-21A is another important part of "the Garlock 2,000"... two thousand different styles of packings, gaskets, and seals to meet all your needs. The only complete line. That's why you get unbiased recommendations from your Garlock representative. Call him today or write for Catalog AD-150.

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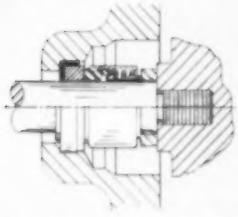
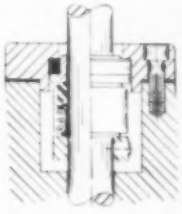
TYPICAL INSTALLATIONS



Centrifugal pump installation where stationary seat fits in housing and impeller provides stop for seal. A cup type vibration ring holds stationary seat. (Vibration ring design optional.)



Vertical shaft installation where lock-nut positions seal on shaft and stationary seat is in gland. A square vibration ring is used to hold stationary seat. (Vibration ring design optional.)

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New trends and developments for design engineers . . .

How to combat abrasion by "wearproofing" critical components with Carboloy® cemented carbides

This is what abrasion can do to a piece of steel:

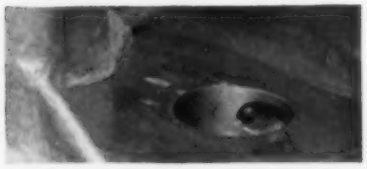

FIGURE 1 — Abrasive damage caused by pivoting arm on pill press.

There is some disagreement among scientists over how the abrasion process actually works. But there is universal agreement among designers over the havoc it wreaks: it shreds, gouges, galls, pits, grinds, and cuts the surface of a material. It ruins equipment, causes excessive repairs and downtime . . . and wastes literally millions of dollars annually in almost every industry.

There is no practical way to eliminate abrasion on most applications. It occurs wherever there is friction between two materials.

There is, however, a simple way to slow down its ravages: "Wearproof" critical machine and product parts with harder, smoother materials.

The hardest materials designers have available are cemented carbides. Carboloy cemented carbides range up to 93 on the Rockwell "A" scale . . . compared to only 84 for SAE 1095 heat-treated carbon steel. Carbides can outwear steel by 10, 50, or as much as 100 to 1.

As for smoothness, cemented carbides take so fine a finish they are in widespread use as gage-blocks accurate to millionths of an inch.

FIGURE 2 — Gage blocks made of cemented carbide. Surface finish of .0005".

This combination of extreme hardness and smoothness has lead to thousands of applications for cemented carbides throughout industry.

For example, nozzles handling abrasive liquids from centrifuges at 1200 psi (Figure 3) are made entirely of Carboloy cemented carbide. The carbide provides a service life of 8 to 12 months — twice that of the rubber-lined nozzles previously used.

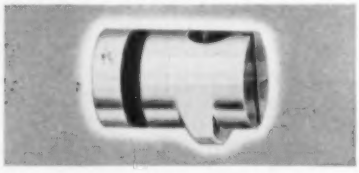

FIGURE 3 — Carbide nozzles on Merco Centrifugal Co. equipment withstand separating forces 9000 times that of gravity.

In the textile industry, carbide guides for high-speed braiders (Figure 4) wear as long as 6 years — compared to an average of 2-3 weeks for conventional hardened steel. The carbide provides more uniform finish, and easily resists the abrasive synthetic fibers.

FIGURE 4 — Carbide stop eyes for high-speed Mossberg braider.

In subsurface pumps for oil wells, Carboloy cemented carbide balls and seats (Figure 5) resist acids and abrasive sands. They outlast steel up to 20 times, and the balls maintain sphericity under the severest conditions of impact and pressure.

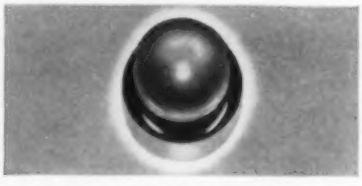

FIGURE 5 — Carbide balls and seats for oil-well pumps.

For power socket wrenches, sockets equipped with Carboloy cemented carbide inserts (Figure 6) outlast ordinary materials 15 to 20 times. The carbide stops product damage from slippage, cuts socket replacement costs.

FIGURE 6 — R. J. Williams power socket wrench uses carbide inserts in sockets.

From the designer's viewpoint, one of the major advantages of carbides is their versatility.

Carbides can be produced in a broad assortment of sizes and shapes — hence there is almost no limit to their design possibilities. And they are available in a wide range of grades — hence almost any combination of physical properties can be produced.

Carbides have high compressive strength—1 to 6 times that of steel. They have tremendous resistance to twisting and deformation under load — 2½ to 3 times that of steel.

These and other unique physical properties are the reasons that carbides are now in use throughout industry, protecting valuable equipment from premature scrapping due to wear. If you have a wear problem—whether abrasion, erosion, friction, or corrosion — carbides may well be the answer.

For design assistance, or technical data on Carboloy cemented carbides, write: *Metallurgical Products Department of General Electric Company, 11127 E. 8 Mile Ave, Detroit 32, Michigan.*

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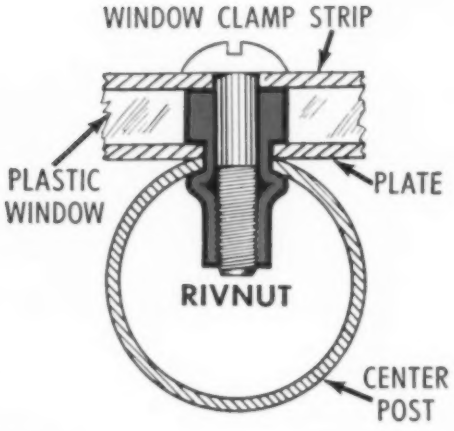
B.F.Goodrich Rivnut

provides blind nutplate so solid it's a shockproof seal

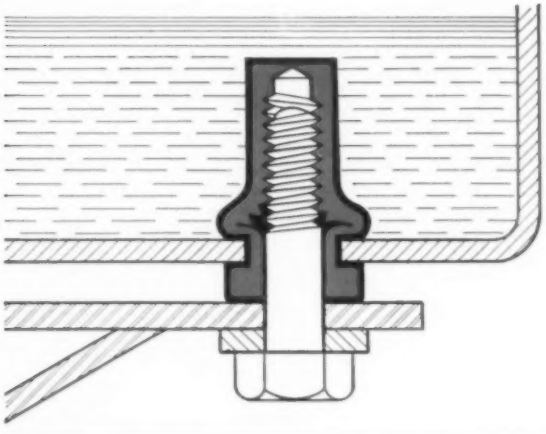


Here's a tough fastening problem that puzzled designers of airplane windows. They needed a nutplate and a blind rivet solid enough to serve as a shockproof seal. One B. F. Goodrich Rivnut solved the problem by performing all three jobs in one operation.

In seconds, one man upsets the Rivnut, securely rivets the plate to center post. The firm bulge in the Rivnut shank conforms to the curvature of the tube, giving a shockproof seal that keeps weather out. Rivnut head serves as spacer for plastic window, and provides 6 clean, firm threads that hold clamp strip and window securely in place.

Best of all, Rivnuts cut costs by reducing assembly time. Here's a typical example:

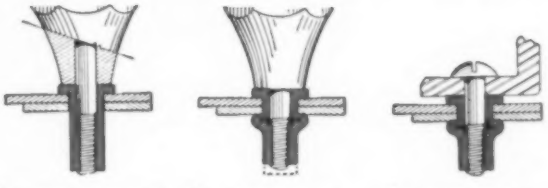
RIVNUT cuts fastening time 90% by eliminating brazing and tapping



A manufacturer of industrial oilers was brazing nutplates on his reservoir tanks for bolting to brackets. This required three separate operations—brazing, tapping, and thread cleaning. Too often, brazing caused warping and leaks. In addition, he had to fuss with bolts and washers to maintain proper shim space.

By switching to Rivnuts, he reduced all three steps to one quick operation. Rivnuts cut assembly time 90%, assured uniform quality in every product. Rivnuts can work wonders for you, too. Call on us for engineering help, or:

HOW RIVNUTS PROVIDE AT LEAST 6 CLEAN THREADS IN ONE SIMPLE OPERATION:



1 Rivnut is threaded onto pull-up stud of heading tool, then inserted.

2 Tool lever operates pull-up stud forming a bulge in the Rivnut shank.

3 After upset, Rivnut threads are still clean and intact, ready for screw attachment.

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how Rivnuts fasten *to* and *with*. Explains construction, gives proved applications. Write to *B. F. Goodrich Rivnuts, Dept. PE-67, Akron, Ohio.*

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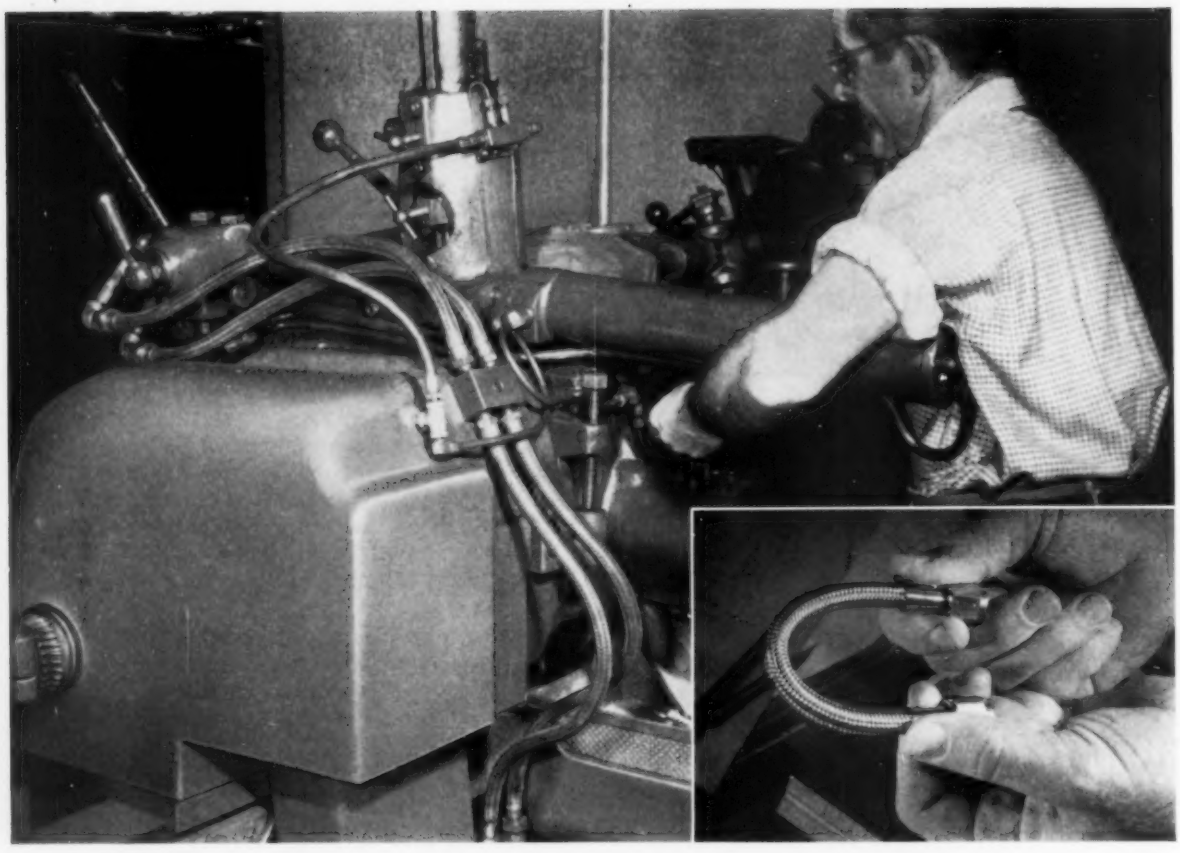


Design high-integrity fluid lines with R/M FLEXIBLE THIN-WALL Teflon* HOSE

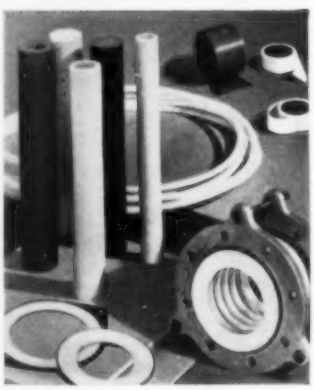
If your design problems include the handling of fluids under conditions of extreme temperature, pressure and corrosion, investigate the possibilities of R/M Flexible Thin-Wall "Teflon" Hose. It retains its toughness and flexibility in temperatures ranging from -100° to 400°F. It withstands pressures (in the wire braid form) to 1500 psi; is completely impervious to all types of acids, caustics and solvents; does not expand, contract or fatigue; and is storable indefinitely without deterioration.

R/M Flexible Thin-Wall "Teflon" Hose can be furnished in both stainless steel wire braid and rubber-covered forms, either coupled or uncoupled.

This hose is another product resulting from R/M's long research in the application of "Teflon." Our laboratories have been developing the vast potentialities of this material for all phases of industry since "Teflon" first came into use. Write today for complete information.

R/M "Teflon" Products: machined parts; rods, sheets, tubes and tape; centerless ground rods held to very close tolerances; stress-relieved molded rods and tubes; gaskets; expansion joints and flexible couplings; bondable "Teflon"; braided metal- and rubber-covered flexible hose; and Raylon (R/M trade name for mechanical grade "Teflon" which has many of the characteristics of virgin "Teflon"). Write for complete data.

*A Du Pont trademark



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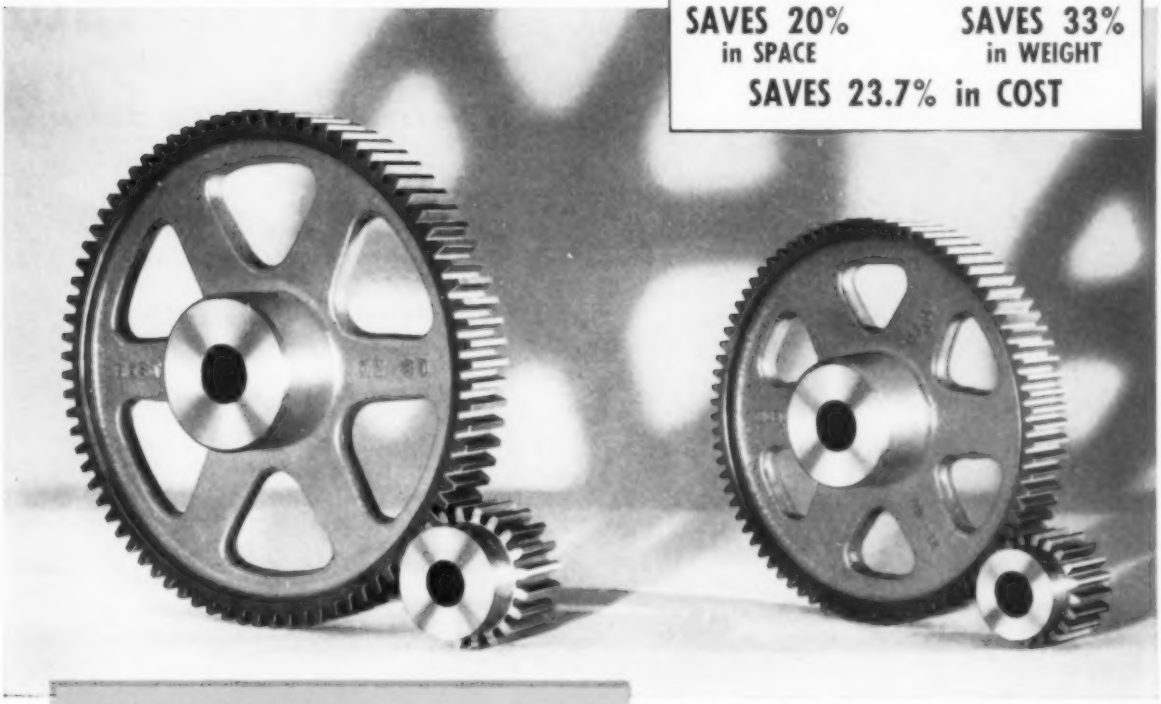
They both meet the job specifications . . . but **one of these gear sets** costs you 23% less

20° PRESSURE ANGLE		COMPARE SAME RATIO	14½° PRESSURE ANGLE	
Pinion	Gear		Pinion	Gear
2"	8"	Pitch Diam.	2.5"	10"
5"		Center Distance	6.25"	
1 lb. 3 oz.	9 lb. 1 oz.	Weight	2 lb. 3 oz.	13 lb. 2 oz.
3.67	14.60	Price	4.72	19.20

SAVES 20% in SPACE **SAVES 33% in WEIGHT**

SAVES 23.7% in COST



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Steel and Iron
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Fine Pitch Brass
64, 48, 32
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Cast Iron
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20 to 3 P.
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Every engineer knows the quiet-running efficiency and high strength of the 20° Pressure Angle tooth form. For most installations, the 20° P. A. Gear that meets specifications saves an average of 20% in space, weight, and cost over the comparable 14½° P. A. Gear required.

Now, the types and sizes of 20° P. A. Gears you need to make these big savings in your assemblies are *available, anywhere in industrial U. S. A. or Canada,* FROM STOCK at BOSTON GEAR Distributors.

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FROM DENISON

How Caterpillar designs rugged hydraulic efficiency into Traxcavator

with Denison's new 2000 psi vane-type hydraulic pump

• Rugged dependability and high operating efficiency have been engineered into Caterpillar's new No. 977 Traxcavator with Denison's balanced-vane hydraulic pump.

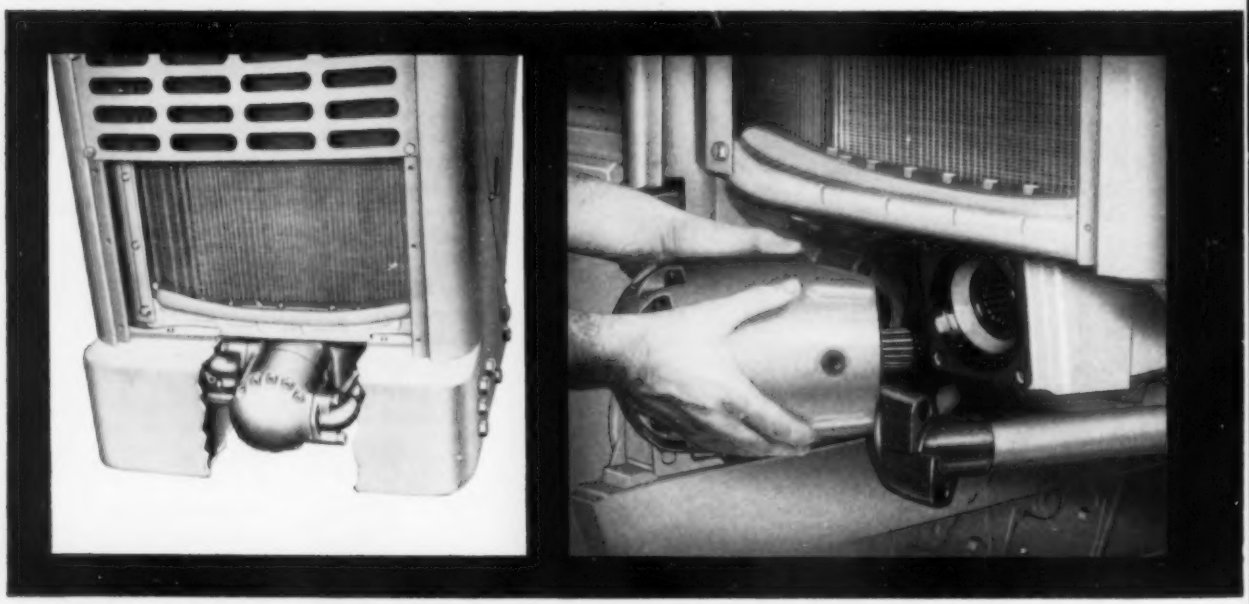
Capable of delivering continuous 2000 psi service, the Denison pump powers the Traxcavator's lifting arms—the real workers on construction equipment of this type. The pump contributes these important design features.

Packs more power . . . 50 h.p. in less space than a conventional 3 h.p. electric motor where weight and space are a premium.

Cold-weather starting . . . under severe weather conditions, to help maintain construction schedules, avoid costly delays.

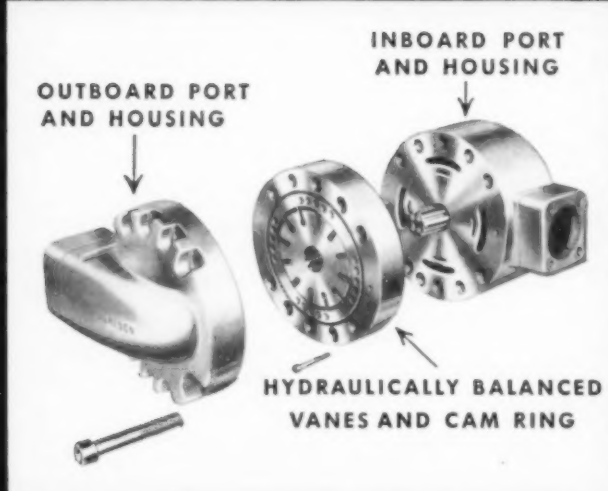
Fast on-the-job servicing . . . pump easily removed and replaced as a unit without special tools or skills.

Long, efficient life . . . fully-balanced vanes and rotors reduce wear on cam rings and thrust plates to give long pump life with minimum maintenance. Internal friction is lower, volumetric efficiency higher. In the Traxcavator, the pump is operated at 1700 psi, further increasing its lifespan.



Denison 2000 psi vane-type hydraulic pump, located at front of engine, is driven through a universal joint.

Complete pump is removable as a unit to simplify servicing in the field. Special tools or skills are not required.



Denison's exclusive cartridge construction. Rugged, specially designed vanes provide dual sealing edges between vane and cam ring.

***NEW* BULLETIN 200** describes how Denison's 2000 psi hydraulic pump can improve the design and operation of all types of mobile equipment and machinery. Write Denison Engineering Division, American Brake Shoe Co., 1194 Dublin Road, Columbus 16, Ohio.

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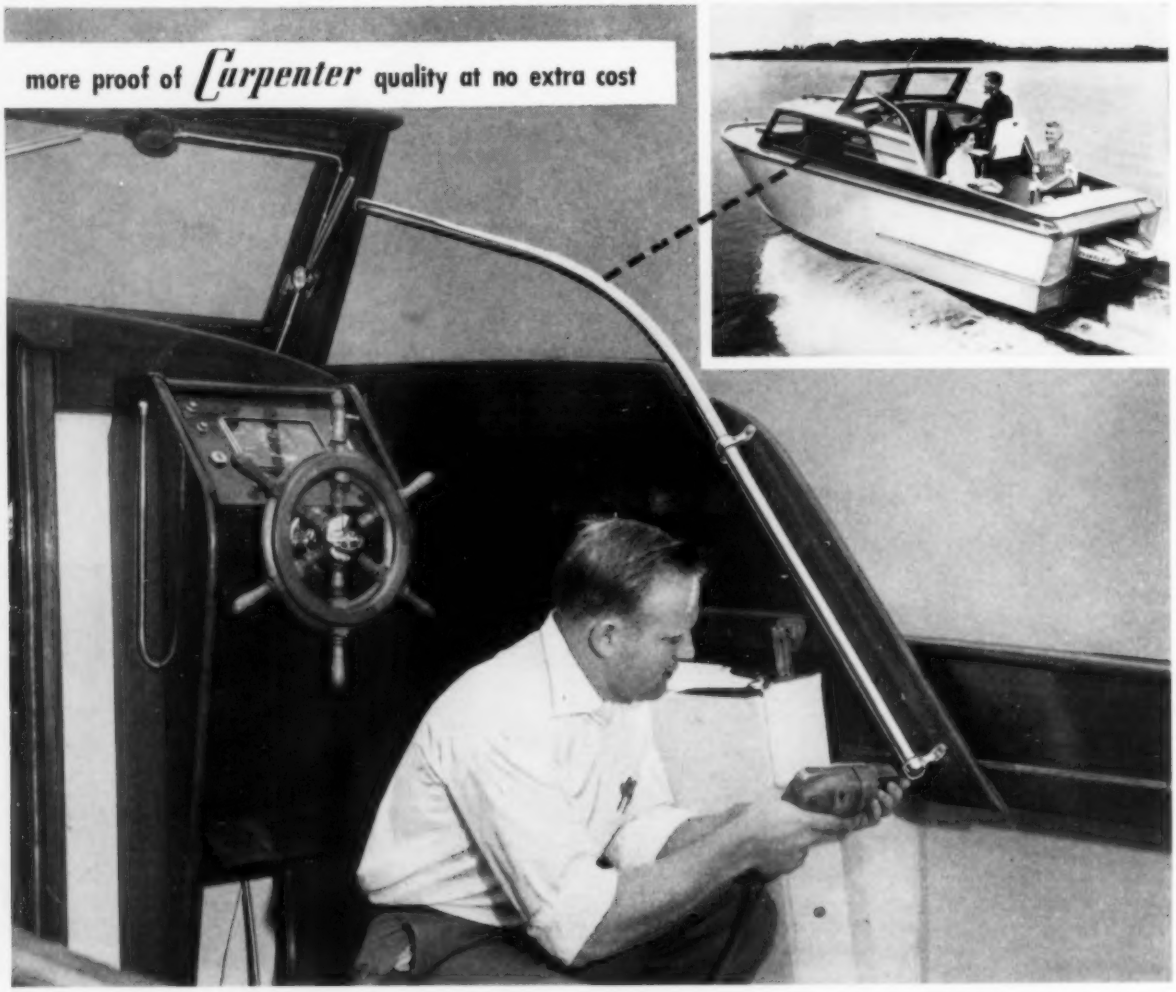

Costs cut 25% on boat handrails by switching to *Carpenter* Stainless Tubing

● Note the reasons why a 1957 line of 22-foot pleasure cruisers features gleaming stainless steel handrails:

By changing to Type 302 Carpenter Stainless Tubing, time and costs of making the handrails has been reduced 25%. Better bendability, improved appearance and no plating to peel in marine atmosphere are other important advantages gained. The tubing is 1" O.D. with 18-gauge wall thickness, and 180-grit polished finish, in 22-ft. lengths.

The boat builder reports that Carpenter Stainless Tubing bends around a special 30-in. radius jig with less spring-back and shows no kinks or marks from bending. For maximum attractiveness, it is polished on a 240-grit and buffed.

Get this cost-saving quality and workability of stainless tubing for your products or equipment by calling your nearby Carpenter Distributor. He's at your service on over 30 different stainless and specialty analyses in a wide range of sizes, gauges, shapes and finishes . . . for pressure, mechanical, structural and sanitary services.

MEMBER

The Carpenter Steel Company
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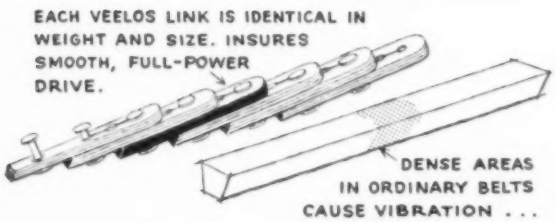
Carpenter

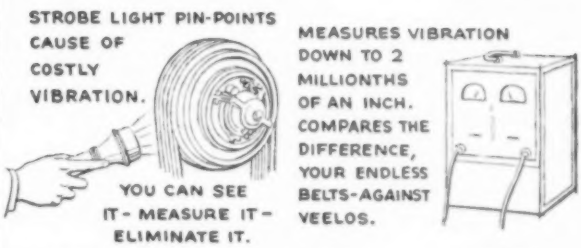
more than corrosion resistance

Stainless Tubing & Pipe

Six Reasons Why Veelos Adjustable V-Belts Are Better For Your Drives!


EACH VEELOS LINK IS IDENTICAL IN WEIGHT AND SIZE. INSURES SMOOTH, FULL-POWER DRIVE.
DENSE AREAS IN ORDINARY BELTS CAUSE VIBRATION . . . MACHINE WEAR

1. Balanced construction of Veelos Belts assures you faster, cleaner work, less rejects . . . less bearing wear. Each link and stud is identical in size and weight. Ordinary belts have varying spots of density which cause excess vibration—chatter marks, machine wear.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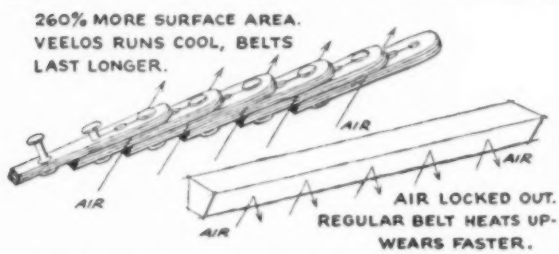
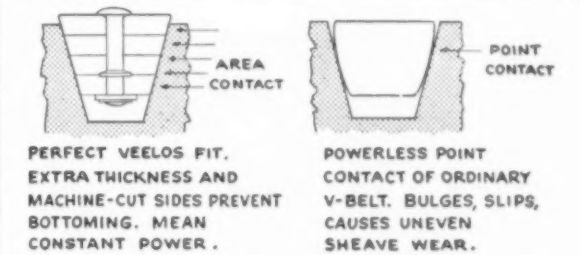
YOU CAN SEE IT - MEASURE IT - ELIMINATE IT.
MEASURES VIBRATION DOWN TO 2 MILLIONTHS OF AN INCH. COMPARES THE DIFFERENCE, YOUR ENDLESS BELTS-AGAINST VEELOS.

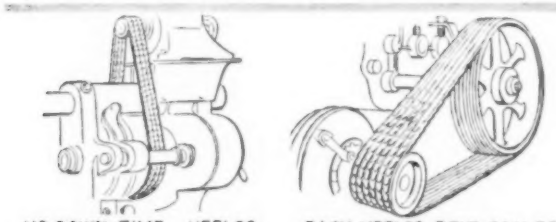
2. Electronic proof—up to 90% less vibration! With a vibration analyzer, you see, on your own machine, how Veelos belts decrease vibration up to 90% over any belt you're now using. This amazing Veelos test pin-points the belt that has the "invisible shakes."



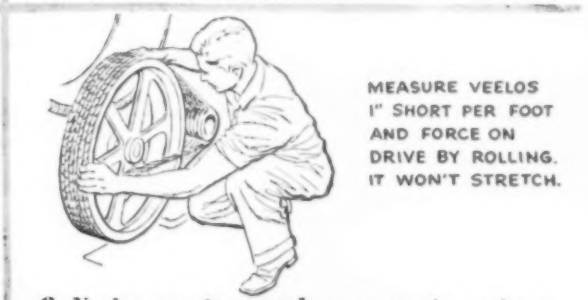
3. Cooler running—long life! Veelos breathes! Constant circulation of air keeps Veelos running smooth. Regular V-belts have no chance to cool, heat builds up from the inside . . . causes slippage, wastes power, heats bearings, reduces belt life.


AREA CONTACT
POINT CONTACT
PERFECT VEELOS FIT. EXTRA THICKNESS AND MACHINE-CUT SIDES PREVENT BOTTOMING. MEAN CONSTANT POWER.
POWERLESS POINT CONTACT OF ORDINARY V-BELT. BULGES, SLIPS, CAUSES UNEVEN SHEAVE WEAR.

4. Greater flexibility reduces slippage! Sectional construction, beveled links allow greater flexibility, longer belt life. Each link moves around sheave independently and maintains full contact, constantly. Full area contact allows shorter centers, smaller sheaves.

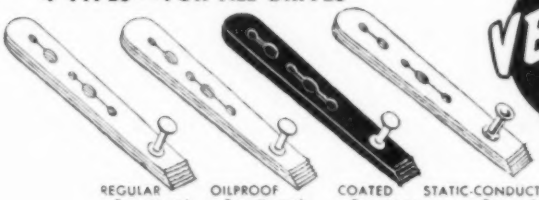

NO DOWN-TIME. VEELOS FITS ANY DRIVE - WITHOUT DISMANTLING.
EACH VEELOS BELT CAN BE ADJUSTED - NO NEED FOR EXPENSIVE MATCHED SETS.

5. Simple installation "knocks out" down-time! Saves up to 50% installation time on outboard bearing drives, more when belt length isn't in stock. No resetting, tilting or moving motors. Veelos can be made any length, can be changed by adding or removing links.



6. Veelos won't stretch any more than ordinary endless V-belts when it is properly installed. *Remember—measure Veelos 1" short per foot and roll on drive as tightly as possible.* With the first few revolutions Veelos studs accept a permanent set into the sections they connect.

4 TYPES — FOR *ALL* DRIVES


REGULAR For general service
OILPROOF For oily and hot drives
COATED For wet or oily drives
STATIC-CONDUCTING For explosive atmosphere

VEELOS
THE BALANCED LINK V-BELT

Known as Veelink outside U.S.A.

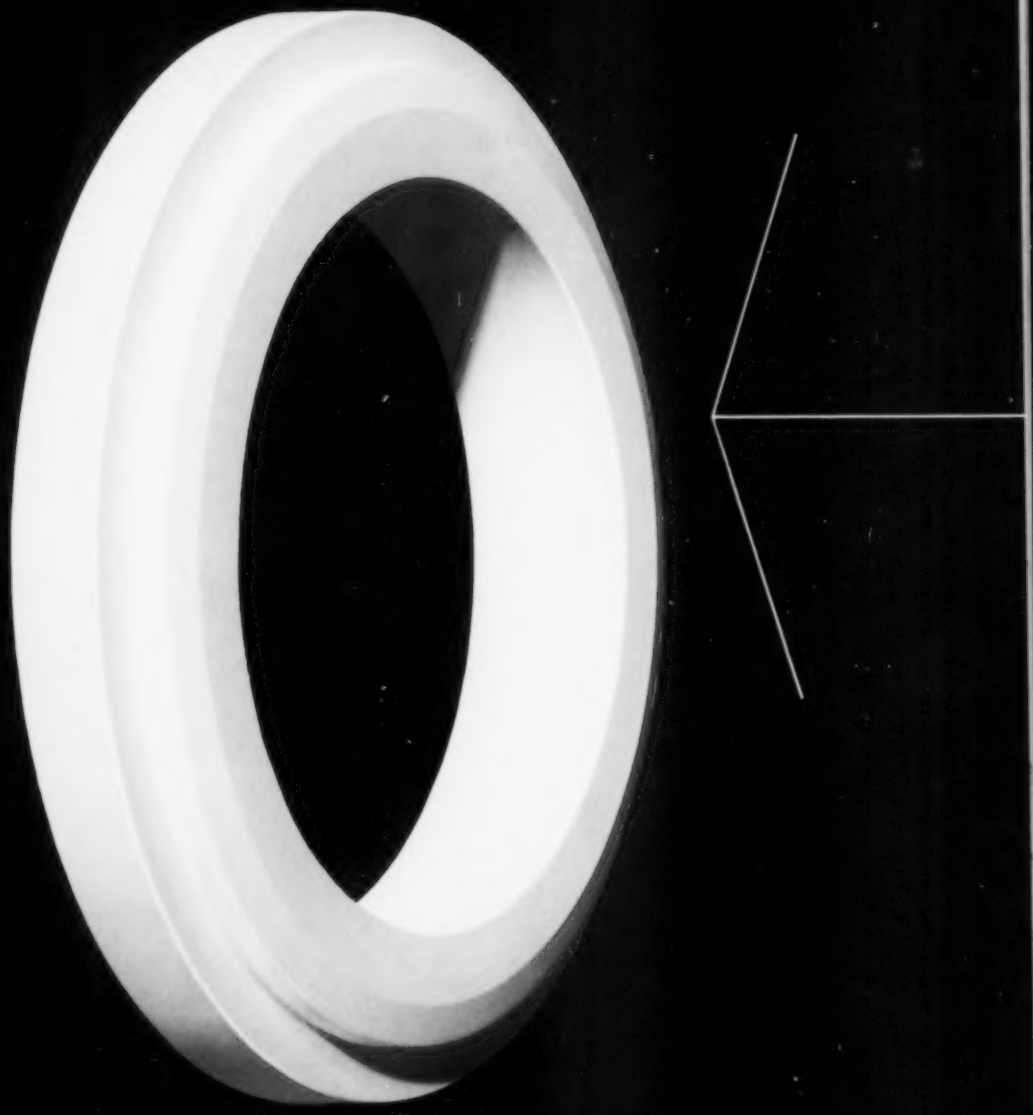
For all sizes and types of drives. Double-V available for serpentine drives.

Write for free Veelos Data Book or Veelos Vibration Demonstration to:

MANHEIM
Manufacturing & Belting Co.
407 Stiegel St., Manheim, Pa.

"Industrial Belt Specialists Since 1911"

© M.M.&B. Co. 1956



THIS IS A COORS HIGH STRENGTH ALUMINA CERAMIC SHAFT SEAL RING FOR A 4" SHAFT

Coors CERAMIC

...how it solves problems of abrasion and corrosion

IN MECHANICAL SHAFT SEALS

Shaft seal rings for pumps and mixers are one of the many ways design engineers are using Coors High Strength Alumina Ceramic to combat corrosion and abrasion. The applications vary from large chemical handling pumps to water pumps for tractors and home appliances.

Solid ceramic shaft seal rings of Coors High Strength Alumina can be used in the presence of most liquids to include all acids except hydrofluoric. The material has a hardness greater than tungsten carbide. Seal faces are lapped to a flatness of two light bands or better, and surface finished for an extremely low friction coefficient. Any shape can be furnished that would normally be made on a lathe. Sizes for shafts up to 4 inches diameter are in regular production, and larger sizes can be supplied.

For testing design of parts, Coors can furnish small quantities of ceramic seal rings at nominal prices. For production quantities, thousands per day may be obtained.

MECHANICAL PROPERTIES

PROPERTY	UNIT	COORS Vitrified High Strength Ceramic TYPE AB-2
Tensile Strength	psi	17,000 - 18,000
Compressive Strength	psi	over 200,000
Flexural Strength	psi	42,000 - 45,000
Specific Gravity		3.40
Hardness	Moh's Scale	9
Maximum Working Temperature	°F	2550
Closest Machined Tolerances	inches	0.000020

DESIGN ENGINEERS—Coors High Strength Ceramic materials and Coors production facilities offer many product design possibilities to engineers where dimensional accuracy, corrosion, abrasion, and heat problems are a factor. For design details and complete mechanical properties, please refer to our 12-page catalog in Sweet's Product Design File.

MECHANICAL SEAL USERS—Mechanical shaft seals using Coors High Strength Alumina Ceramic may be obtained from most manufacturers of mechanical shaft seals.

COORS PORCELAIN COMPANY

Manufacturers of High Strength Alumina Ceramics

©1957, Coors Porcelain Co. Litho USA

LONG OIL COOLERS CAN HELP SELL YOUR PRODUCTS

For top efficiency from heavy-duty powered equipment, the oil in engines, transmissions, torque converters and hydraulic units must be protected from heat. As their operating requirements are stepped up, this problem becomes more acute.

GIVE your customers the benefits of *Long* thermally and mechanically efficient oil coolers, built by this 53-year leader in heat exchangers. *Long* engineers' design ingenuity in combining standard elements enables us to produce a wide variety of sizes, capacities and shapes without high tooling costs.

- Available in wafer, multiple plate, shell and tube, fin and tube, and manifold types
- For single or multi-pass, oil to water and oil to air cooling
- Applicable to automotive, industrial, marine, hydraulic and other mobile or stationary powered units
- Designed for installation in radiator tank, engine block or as an accessory
- Quality and performance tested and proved in *Long* laboratory

Write for engineering data sheets and information forms to obtain application recommendations. If you need immediate help, ask to have a representative call on you.

TORQUE CONVERTERS
CLUTCHES
HEAT EXCHANGERS

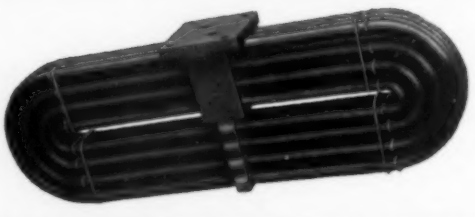
LONG MANUFACTURING DIVISION
BORG-WARNER CORPORATION

12501 Dequindre Street, Detroit 12, Michigan
Also: Oakville, Ontario, Canada
Export Sales: Borg-Warner International
36 South Wabash St., Chicago 3, Illinois

THE STANDARD OF QUALITY AND PERFORMANCE SINCE 1903

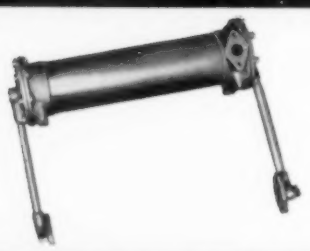
Plate type oil cooler is highly flexible and efficient for engine installation or for torque converters, transmissions or hydraulic presses.

Wafer type, submerged in lower radiator tank, cools transmission oil in automobiles.



Large capacity of manifold type, fabricated from seamless copper tubing, makes it suitable for heavy-duty engines.

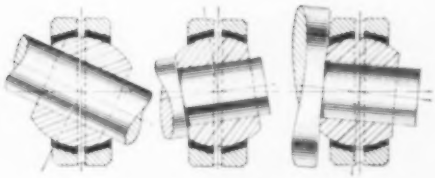
Fin and tube unit can be used for liquid to air cooling wherever a fan can be installed behind it. Suitable for vehicles, factories, trains and power plants.



Shell and tube liquid to liquid heat exchanger is applicable to vehicles and industrial purposes and as process cooler in manufacturing fluid products.

HEIM BEARING

Cutaway Shows
Housing— Bronze Inserts—
Hardened, Ground Ball



Maximum angle of misalignment

HEIM *Unibal* BEARINGS

Correct misalignment in every direction.

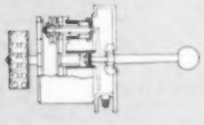
Carry heavier axial and thrust loads.

Reduce friction and lost motion.

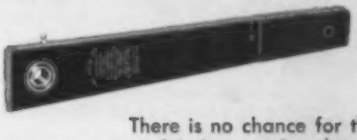
Eliminate brinelling.

Economical to buy — easy to install.

A few examples of Unibal applications:

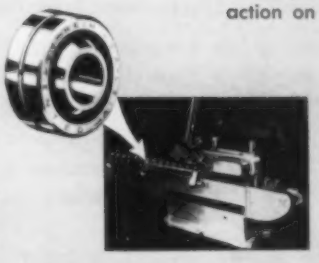


The pivot point for the operating lever which trips the motor switches controlling the searchlight is a Heim Unibal Bearing. This is a Carlisle & Finch electric searchlight controller.



There is no chance for the stud hole to enlarge in this sweepstick. The Heim Unibal Bearing assures smooth, trouble-free pick action on any loom.

The transmission shifter rod on the giant Failing Oil Well Drilling Rig passes through this Heim Unibal to misalign with the changing position of the shaft.



This end of the Helicoid Timer on the Anchor Steriseal Machine is supported by a self-aligning Heim Unibal Bearing.

The Heim catalog shows the complete range of sizes and load ratings. Please write for copy, or for specific engineering data.

THE HEIM COMPANY / Fairfield, Connecticut

NEW NICHOLSON *Model 300*

"4-way" control valve

Versatile flat-disc type valve is drop-tight . . . provides sensitive throttling action for a variety of rugged control applications.

If you need precise, repeatable control of double-acting cylinder-actuated mechanisms . . . you'll want to try this new advanced-design valve. Ruggedly constructed of a combination of corrosion-resistant materials, it can be used with air, water, gas and oil. Check its features, send for literature.

Send for your copy of new Bulletin 300 . . . for details on design, construction, sizes and applications.

Outstanding features:

- **Trapezoidal ports for modulated throttling.**
- **One-shot lubrication, reservoir in base.**
- **Leak-proof O-ring packing and seal.**
- **Easily adapted to single cylinder control.**
- **Low maintenance, easily disassembled.**
- **Simple, reversible mounting clamp and lugs.**

NICHOLSON

W. H. NICHOLSON *and Company*

VALVES • TRAPS • FLOATS • METAL PARTITIONS • LAUNDRY, DRY CLEANING, AND PRESSING MACHINERY • HOSPITAL CUBICLES

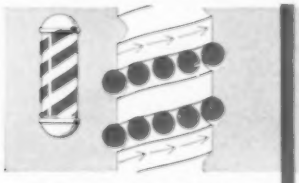
14 OREGON STREET, WILKES-BARRE, PA. • SALES AND ENGINEERING OFFICES IN 98 PRINCIPAL CITIES

These MODERN Recirculating Ball Units can help you...

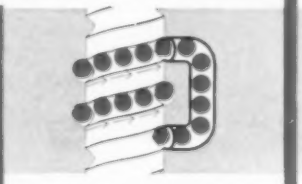
SOLVE ACTUATION and TORQUE PROBLEMS

Saginaw b/b Screws guaranteed 90% efficient —offer 6 major advantages for designers

Available in custom machined and commercial rolled thread types—have been built from 1½ inches to 39½ feet long—⅜ to 10 inches diameter.



Nut *glides* on steel balls. Like stripes on a barber pole, the balls travel toward end of nut through spiral "tunnel" formed by concave threads in both screw and mating nut.



At end of trip, one or more tubular guides lead balls diagonally back across outside of nut to starting point, forming closed circuit through which balls recirculate.

1 VITAL POWER SAVINGS. With guaranteed efficiency of 90%, Saginaw b/b Screws are up to 5 times as efficient as Acme screws, require only ⅓ as much torque. This permits much smaller motors with far less drain on the electrical system. Circuitry is greatly simplified.

2 SPACE/WEIGHT REDUCTION. Saginaw b/b Screws permit use of smaller motors and gear boxes; eliminate pumps, accumulators and piping required by hydraulics. In addition, Saginaw b/b Screws themselves are smaller and lighter. Units have been engineered from 1½ in. to 39½ ft. in length.

3 PRECISE POSITIONING. Machine-ground Saginaw b/b Screws offer a great advantage over hydraulics or pneumatics because a component can be positioned at a predetermined point with precision. Tolerances on position are held within .0006 in./ft. of travel.

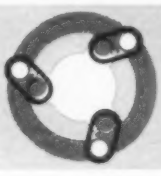
4 TEMPERATURE TOLERANCE. Normal operating range is from −75° to +275° F., but assemblies have been designed in selected materials which function efficiently as high as +900° F. These units are practical where hydraulic fluids have lost efficiency or reached their flash point.

5 LUBRICATION LATITUDE. Even if lubrication fails or cannot originally be provided because of extreme temperatures or other problems, Saginaw b/b Screws will still operate with remarkable efficiency. Saginaw units have been designed, built and qualified for operation without any lubrication.

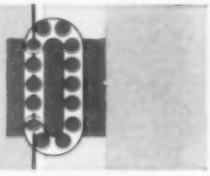
6 FAIL-SAFE PERFORMANCE. Far less vulnerable than hydraulics. In addition, Saginaw offers three significant advantages over other makes: (1) Gothic arch grooves eliminate dirt sensitivity, increase ball life, (2) yoke deflectors and (3) multiple circuits provide added assurance against operating failure.

Saginaw b/b Splines average 40 times lower friction coefficient than sliding splines

Transmit or restrain high torque loads far more efficiently—have been built from 3 inches to 10 feet long—⅜ inch to 6 inches in diameter.



The *Saginaw b/b Spline* radically increases the efficiency of transmitting or restraining high torque loads. Instead of *sliding* against each other, surfaces *glide* on rolling balls.



The steel balls recirculate in closed circuits formed by mating longitudinal raceways spaced around the circumference of inner and outer splines. Guides return balls.

This revolutionary new kind of spline utilizes the same basic principle pioneered by Saginaw in the ball/bearing screw.

It permits new engineering designs never before practical—literally lets you achieve the "impossible"! In any application where column length must change under torque load, the Saginaw b/b Spline offers greatly decreased friction, less wear, longer life, more dependable operation. It can be fitted with integral gears, clutch dogs, bearing and sprocket seats or a wide choice of other attachments for use with electric, hydraulic or pneumatic units. To convert push-pull to rotary motion, helical types are available with very high leads, ranging from 20:1 to 100:1.

SEND TODAY FOR THIS FREE 1957 ENGINEERING DATA BOOK...

or see our section in Sweet's Product Design File

Saginaw ball bearing Screws and Splines

SAGINAW STEERING GEAR DIVISION OF GENERAL MOTORS

WORLD'S LARGEST PRODUCER OF BALL BEARING SCREWS AND SPLINES

Saginaw Steering Gear Division
General Motors Corporation
b/b Screw and Spline Operation
Dept. 4J, Saginaw, Michigan

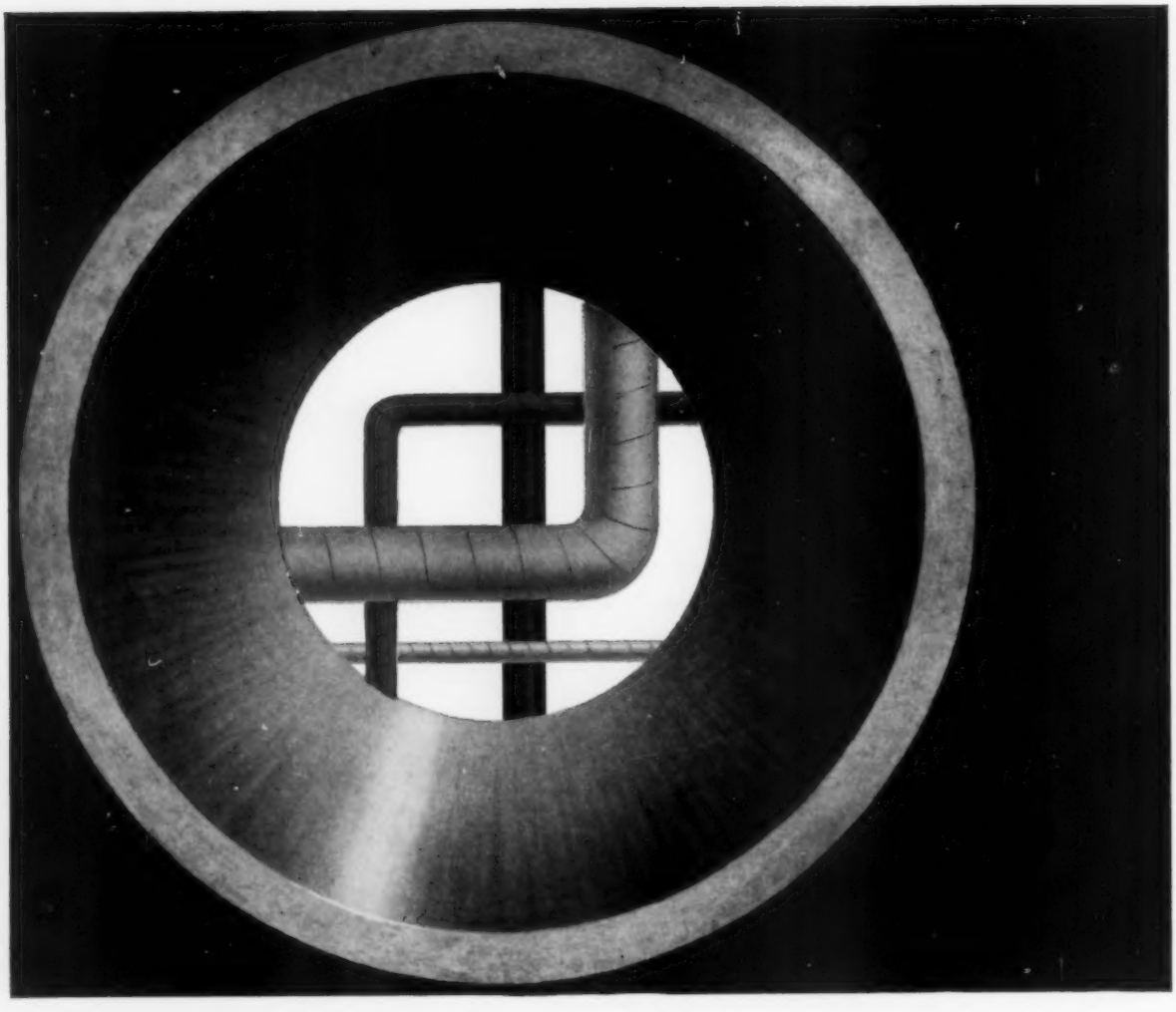
Please send new engineering data book on Saginaw b/b Screws and Splines to:

NAME _____

COMPANY _____ TITLE _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____



Enjay Butyl—*today's super-rubber*

improves pipeline protection...cuts costs!

Plicoflex® Tape Coating, revolutionary new pipeline wrapping developed by Plicoflex, Inc., combines the outstanding protective properties of Enjay Butyl Rubber with the identification properties of a color-bearing plastic film to which the Butyl is laminated. Applied over an Enjay Butyl based primer and forming a permanent bond to the metal, the tape features: absolutely *no* moisture migration or penetration; exceptional resistance to shock-impact; excellent dielectric properties, and outstanding resistance to normal and unusual corrosive influences. This *cold-applied* wrapping is *safer* and *cheaper* to apply by hand or machine than hot coatings and requires fewer personnel.

This is still another in the steadily growing number of products developed with Enjay Butyl Rubber. Contact the Enjay Company for complete information about this truly *wonder* rubber . . . where it can help *you!* Complete laboratory facilities, fully staffed by trained technicians, are at your service.

ENJAY BUTYL

Enjay Butyl is the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.

ENJAY *Pioneer in Petrochemicals*

ENJAY COMPANY, INC., 15 West 51st Street, New York 19, N. Y.

Akron • Boston • Chicago • Los Angeles • New Orleans • Tulsa

NOTHING *can equal Stainless Steel*

in its unique combination of properties

No other design material can match Stainless Steel in its combination of desirable properties: corrosion resistance, strength, hardness, beauty, cleanability and easy fabrication. For a reliable source of supply, United States Steel offers you the widest range of types, finishes and sizes.

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS STAINLESS STEEL

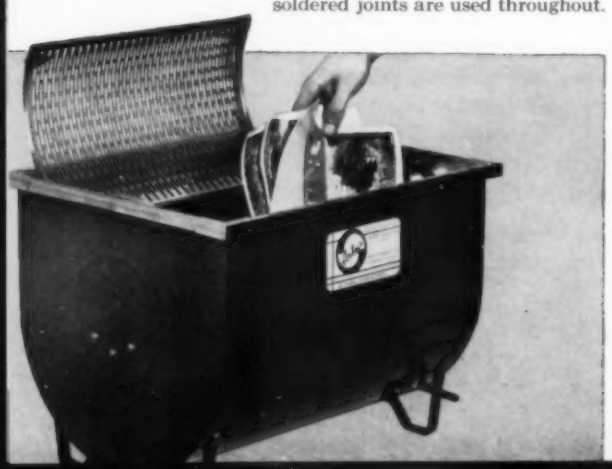
SHEETS • STRIP • PLATES • BARS • BILLETS
PIPE • TUBES • WIRE • SPECIAL SECTIONS

USS

UNITED STATES STEEL

FOR HIGH TEMPERATURE STRENGTH. The Ryan Firebee is a pilotless jet airplane that flys about 600 mph at altitudes up to 40,000 feet. All three armed services are using it for target practice—to simulate attacking aircraft. Fuselage and turbojet engines use substantial quantities of Stainless Steel—mostly because of its excellent strength/density ratio at elevated temperatures.

FOR CORROSION RESISTANCE. If you're a photographer, you know that hypo is awfully corrosive. This print washer (it holds 75 8x10 prints in one loading) is made completely from Stainless Steel by the Arkay Corporation, in Milwaukee. For proof that Stainless is easy to fabricate, notice that the drum has 1,700 perforations, and double lockseam soldered joints are used throughout.

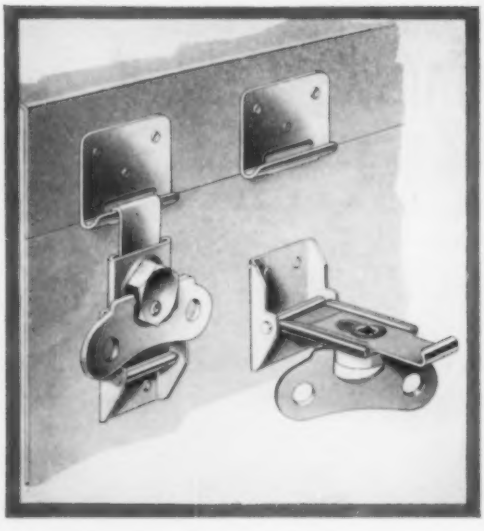


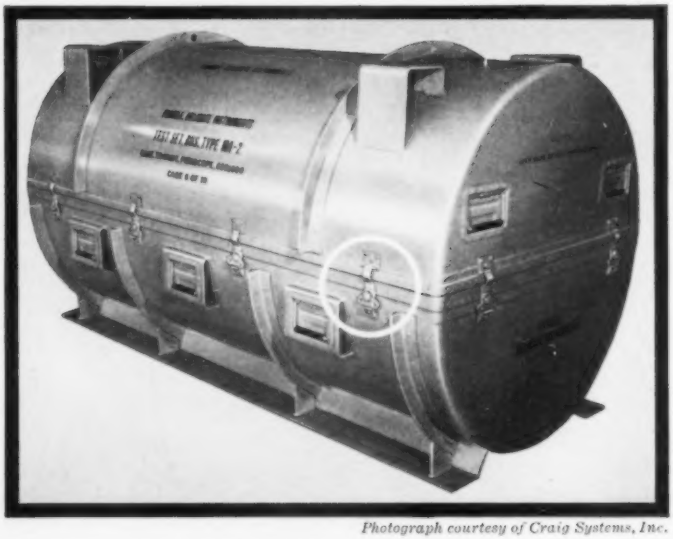
FOR TAKING A BEATING. These supermarket check-out counters are made from USS Stainless Steel. They withstand the pounding of heavy containers and are unaffected by corrosive meat and produce juices. It only takes 20 minutes for one girl to clean all eleven counters shown here. The Robert Becht Company of Cincinnati made them.

Note—Commercial and Military Packaging Engineers:

Rugged LINK-LOCK

...your best answer to exacting closure problems





Photograph courtesy of Craig Systems, Inc.

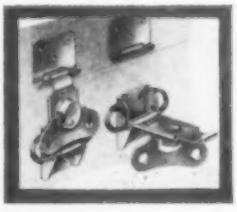
LINK-LOCK provides pressure-tight closure on this rigidly specified equipment container

Simmons LINK-LOCK provides quick opening and closing as well as impact-resistant dependability on transit cases manufactured by Craig Systems, Inc., Danvers, Mass.

The cylindrical Craig container above is gasketed and pressure-tight, and contains delicate electronic equipment. Twelve LINK-LOCK fasteners are used on this model.

Here's why LINK-LOCK is ideal for use on military cases produced to exacting specifications as well as on inexpensive commercial containers:

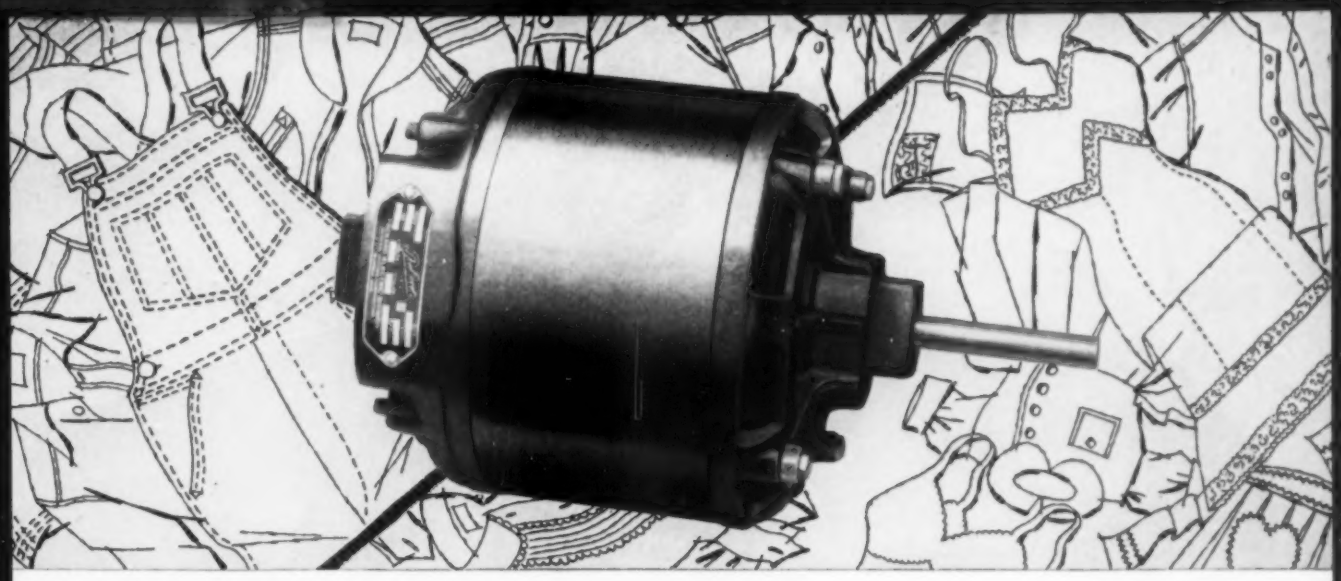
- Impact and shock resistant (positive-locking).
- High closing pressure with light operating torque..... insures pressure-tight seals where required.
- Available in 3 sizes, for heavy, medium, and light duty.
- Compact design...lies flat against case even when unlocked.
- Opening and closing by wing-nut, screwhead, or hex nut.
- Flexible engagement latch design...can be varied to suit different conditions.



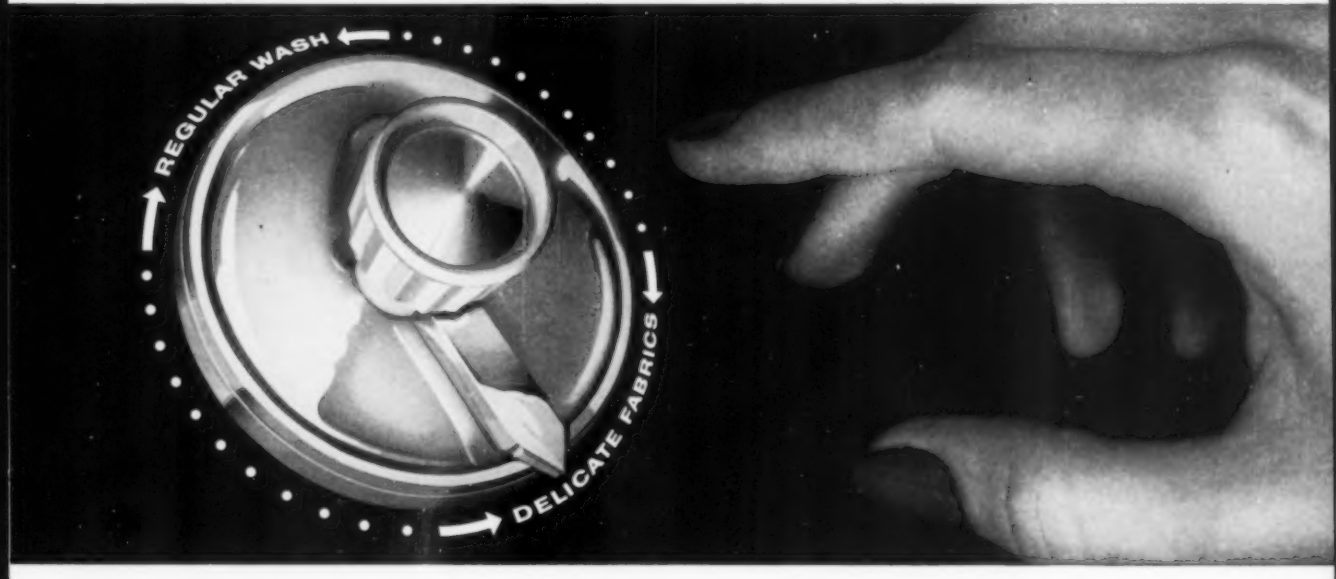
Also available: Spring-Loaded LINK-LOCK. Ideal for the less expensive containers where costs won't permit precision production. Spring provides take-up to compensate for set in gasketing, irregularities of sealing surfaces, and mounting inaccuracies.

Where does the versatile Simmons LINK-LOCK belong in your design? For complete information and specifications, send for the Simmons Catalog today. Samples and engineering service available upon request.

SIMMONS
FASTENER CORPORATION
1751 North Broadway, Albany 1, New York
QUICK-LOCK • SPRING-LOCK • ROTO-LOCK • LINK-LOCK • DUAL-LOCK



PACKARD ELECTRIC / *NEW... custom-tailored washing machine motor*



FHP MOTORS / *Provides power for two washing speeds... electrically!*

It's an old idea based on need. Make the agitator speed variable. Then, both light and heavy clothes could be thoroughly washed without harming fabrics.

There were no two-speed appliance motors available with enough power at both speeds. Mechanical means, such as gears, belts and pulleys, clutches, etc., cost too much, took up too much space, made too much noise and caused too many maintenance problems.

A Packard Electric motor engineering team was first to solve the problem with a compact, two-speed unit that had just the amount of speed, power and torque required. And washing machine manufacturers who worked out the solution with Packard Electric engineers have had a big competitive advantage ever since.

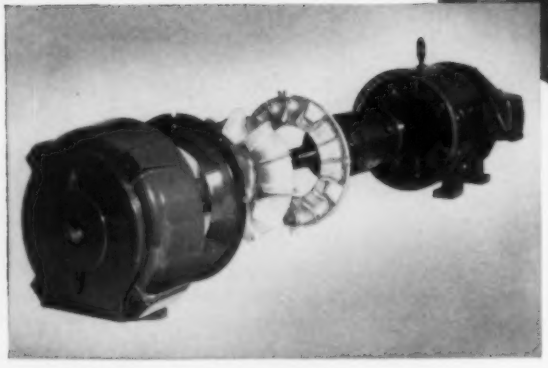
What's more, there are further savings in assembly when you buy Packard. That's because Packard will deliver a motor complete with special mountings and accessories to simplify your assembly procedures.

Packard Electric research and engineering teams have a long record of accomplishment in the custom-built motor field. And, even now, new ideas are on the boards to help our customers produce better, lower priced products for the appliances of tomorrow.

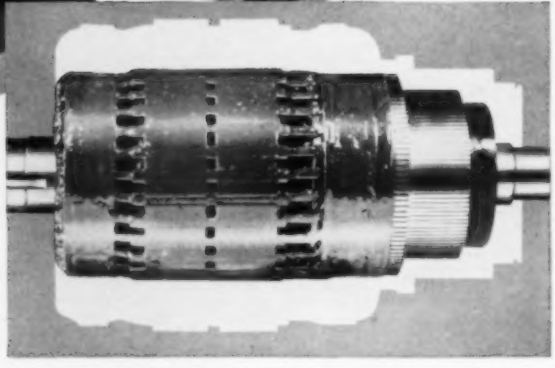
Packard Electric

Warren, Ohio — GM GENERAL MOTORS

Division of General Motors



NEW CONTROLLED VENTILATION—pushes air through the motor from drive end to commutator end, opposite to the ordinary direction. Armature cooling is increased... harmful brush dust created at the commutator is blown out of the motor.



NEW LEVEL OF RESPONSE—Improved ventilation makes up to 55% lower armature inertia possible without sacrifice in capacity. Life-Line "H" gives the fastest accelerations and regulating speed changes for more and better production.

Westinghouse *Life-Line H* with silicone insulation

FASTEST RESPONSE OF ANY STANDARD INDUSTRIAL MOTOR

Life-Line® "H" Backs Up Lowest Inertia With High Commutating Ability for Increased Production

Highly responsive drives are essential to fast automatic processing. No other d-c drive provides as fast speed changes as the Westinghouse Life-Line "H".

Efficient controlled ventilation makes possible the long, slim design of the Life-Line "H" armature, reducing inertia as much as 55% without sacrificing any capacity. 35% increase in commutating ability backs up this lowest inertia to produce the fastest response available in standard industrial d-c motors today.

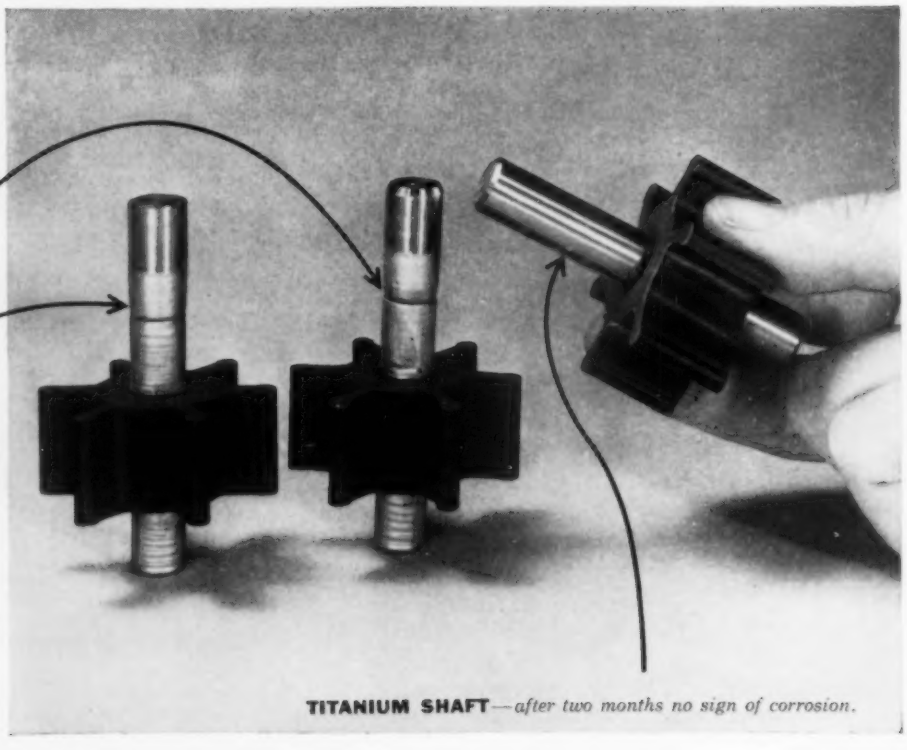
In addition, the new Life-Line "H" with silicone insulation, offers many dividends in long-term dependability and minimum maintenance. For all the facts about Life-Line "H" call your Westinghouse sales engineer. Or, write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa. Ask for B-7056. J-21991-C

NEW HOUSING DESIGN—provides maximum protection—eliminates need for splashproof enclosures in many cases. All access openings are sealed with covers . . . single ventilation opening in each bracket faces directly down.

YOU CAN BE SURE... IF IT'S

Westinghouse

Progress with **TITANIUM**



SHAFTS WHICH FAILED AFTER 45 MINUTES. *Both are made of premium metals, one ferrous, one non-ferrous.*

TITANIUM SHAFT—*after two months no sign of corrosion.*

TITANIUM PUMP SHAFT LASTS

...where other metals corroded in 45 minutes

The problem was to pump ferric chloride, an acid used in etching printed circuits in electronics manufacturing. Jabsco Pump Company, of Burbank, California, sought to develop a pump to handle this highly corrosive acid, and replace batch handling.

Premium metals were tried for the pump shaft (the impeller is neoprene and the casing is plastic), but corrosion around the seal almost immediately led to leakage and failure. A glass shaft did not have sufficient strength. Then, using Mallory-Sharon commercially pure titanium for the shaft, the problem was solved—permanently. Titanium has outstanding resistance to chlorides.

The cost figures here are illuminating. The pump with the titanium shaft cost about double the pump with the ferrous metal shaft . . . and about the same as the pump with the other non-ferrous metal shaft (because of machining difficulty with the latter). So first cost of titanium is lower than you may think. And titanium paid for itself in *90 minutes*.

Let us help you apply titanium to your corrosion problems . . . our service engineering group will be glad to assist. For information, write Dept. P-6.

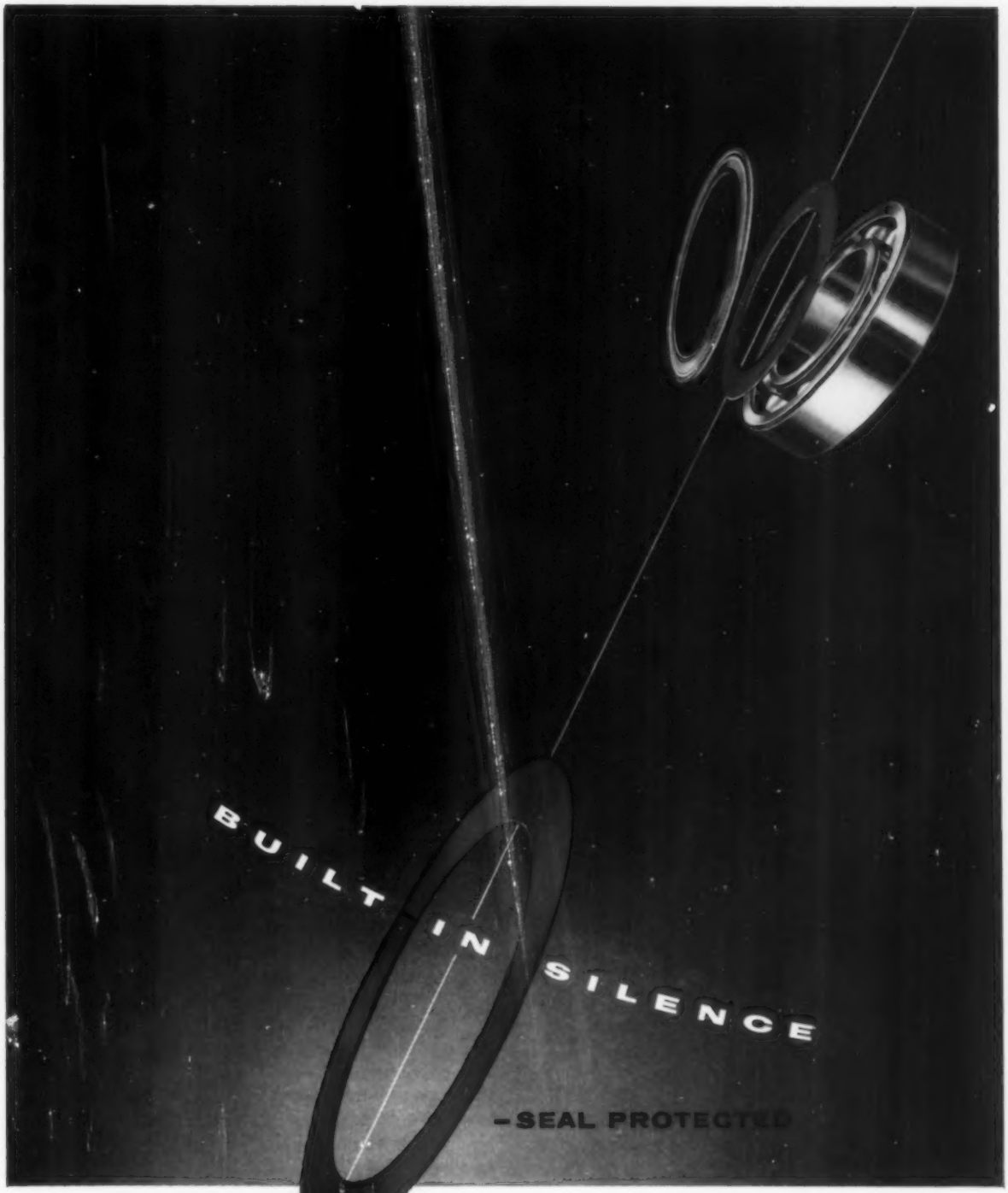
TYPICAL PRESENT APPLICATIONS OF TITANIUM

Anodizing racks	Impellers
Condenser inserts	Piping
Filters	Process vessels
Heat exchangers	Steam jet diffusers

MALLORY Ti SHARON

MALLORY-SHARON TITANIUM CORPORATION · NILES, OHIO

Producers of titanium and titanium alloy sheet, strip, plate, rod, bar, billets



SKF®

EVERY TYPE—EVERY USE

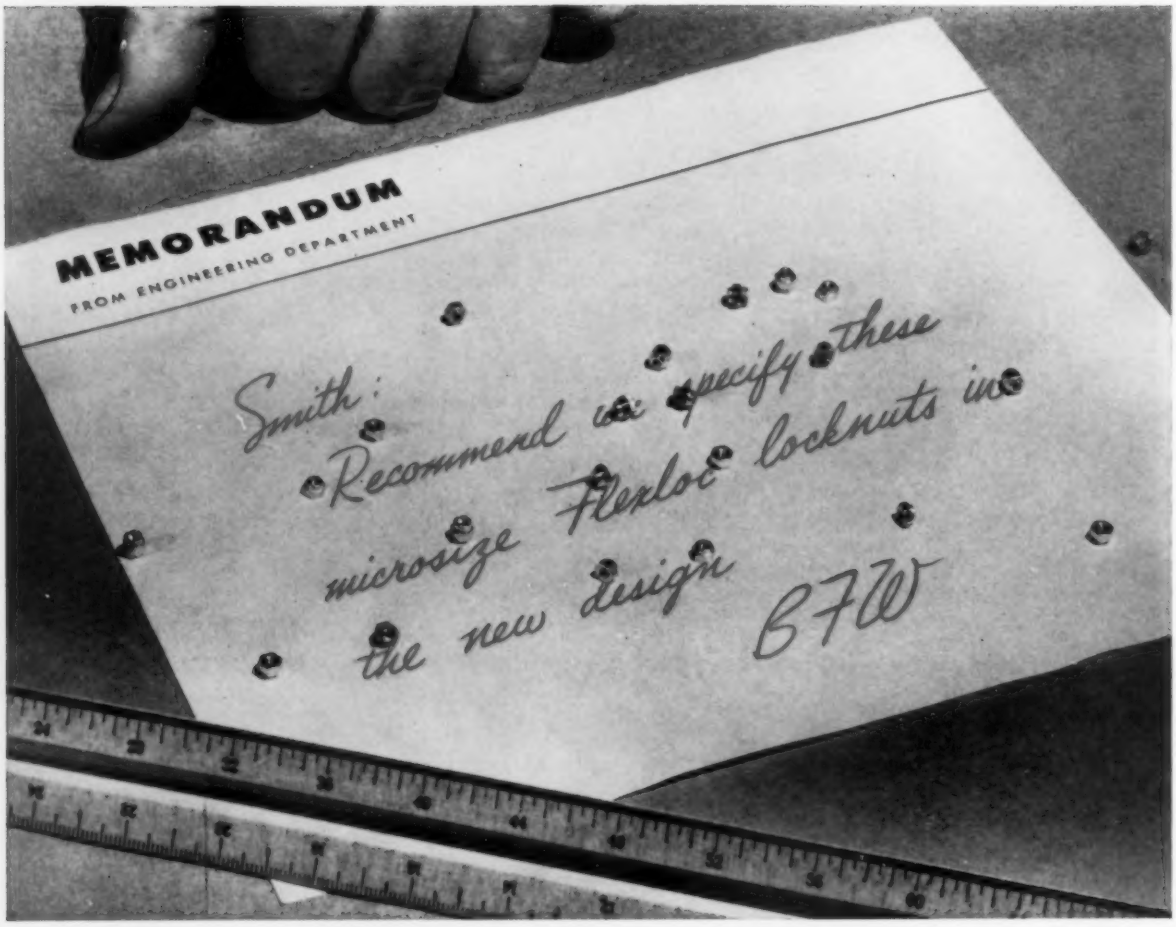
- Ball Bearings
- Cylindrical Roller Bearings
- Spherical Roller Bearings
- Tapered Roller Bearings ("Tyson")

7762

*Reg. U.S. Pat. Off. Tyson Bearing Corporation

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.

The most silent rolling contact bearing in the world of today



Microsize FLEXLOC locknuts help you design smaller assemblies and fasten them securely

SIZE	Across Flats MAX.	Across Flats MIN.	Hex. Height REF.	Across Corners MIN.	Height REF.
0-80 NF-3B	.111	.107	.046	.121	.075
1-64 NC-3B	.127	.123	.056	.140	.090
1-72 NF-3B	.127	.123	.056	.140	.090
2-56 NC-3B	.158	.153	.067	.176	.105
2-64 NF-3B	.158	.153	.067	.176	.105
3-48 NC-3B	.190	.183	.071	.210	.120
3-56 NF-3B	.190	.183	.071	.210	.120
4-40 NC-3B	.190	.183	.071	.210	.120
4-48 NF-3B	.190	.183	.071	.210	.120

Standard microsize FLEXLOC locknuts are available in brass (plain or cadmium plated) and aluminum (plain or chemically treated) for temperatures up to 250°F; in alloy steel (plain or cadmium plated) and 18-8 stainless steel (silver plated) for temperatures up to 550°F.

STANDARD PRESSED STEEL CO.

FLEXLOC® LOCKNUT DIVISION SPS

JENKINTOWN PENNSYLVANIA

Microsize FLEXLOC locknuts save space and reduce weight in electronic equipment, instruments, servomechanisms, and other small assemblies in which weight and bulk are important design considerations. Microsize FLEXLOC locknuts are smaller and lighter than regular FLEXLOCS of the same nominal diameter. They permit smaller mating joints or flanges —with no loss in holding power or convenience of assembly.

Like regular FLEXLOCS, microsize FLEXLOC locknuts are of one-piece, all-metal construction. No inserts to pop out or deteriorate; nothing to put together, come apart or get lost. FLEXLOCS lock and stay locked wherever wrenching stops. You can use them as locknuts or stop nuts. Vibration will not loosen them and they can be used many times over.

For more information on microsize FLEXLOC locknuts (or microsize FLEXLOC self-locking clinch nuts), see your local FLEXLOC distributor or write STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.

JUNE
1957

DOW

Plastiatrics

DOW'S CLINICAL APPROACH TO HEALTHY PLASTICS APPLICATION

RESEARCH DETERMINES CHEMICAL RESISTANCE OF DOW PLASTICS

A typical test under way in the Dow Plastics Technical Service laboratory. This "dunking machine," designed by Dow technical men, tests finished plastics moldings under accelerated use conditions. Any cycling schedule desired can be established on each of its five stations.

ABILITY OF DOW PLASTICS TO WITHSTAND ATTACK BY MORE THAN 350 CHEMICALS TESTED

Industry has recognized the important role of plastics. And, as the range of application possibilities increases, the chemical resistance of these plastic materials becomes critical. The ability of a plastic to withstand chemical attack by certain specific reagents often determines the selection for a given application.

The Dow Chemical Company, as a major supplier of plastic materials to industry, has recognized this problem. Under the direction of Dow Plastics Technical Service, a program of exhaustive tests has been under way for a number of years to provide fundamental data on the chemical resistance of all Dow plastics. More than 350 different chemicals and food ingredients, for example, have been tested to determine their effect on the numerous Styron® formulations. Similar data has been collected on Saran, Ethocel®, Styrex® 767, and Polyethylene.

This data has proved invaluable to manufacturers in making a proper selection of plastic materials for specific applications. Plastiatrics studies and research continue in this and similar areas in an effort to find practical solutions to problems in plastic applications. For your copy of "Chemical Resistance of Dow Plastics," write THE DOW CHEMICAL COMPANY, Midland, Michigan, Plastics Sales Dept. PL 1543G.

AMERICA'S FIRST FAMILY OF POLYSTYRENES

GENERAL PURPOSE
- STYRON 666
- STYRON 665 (Extrusion)
- STYRON 688 (Easy Flow)
- STYRON 689 (Easy Flow)

HIGH IMPACT
- STYRON 475
- STYRON 777 (Medium Impact)
- STYRON 440 (Heat Resistant)
- STYRON 480 (Extra-High Impact)

HEAT RESISTANT
- STYRON 683
- STYRON 700

YOU CAN DEPEND ON DOW

PLANT ENGINEERS CUT LABOR TIME 75%

WITH NEW CORROSION-FREE DRAINAGE SYSTEM

Industry develops new easy-to-install low cost drainage pipes and fittings of PVC based on EXON 402-A

. . . another use typical of the Pin-Pointed Properties in Exon Vinyl resins

Tube Turn Plastics, Inc., timed a journeyman plumber as he made a bell and spigot joint in a 2" Schedule 40 alloy cast iron line. *It took 3 minutes, 45 seconds.*

Then he joined a length of new 2" Schedule 40 PVC pipe to a newly developed PVC socket type solvent welding drainage fitting. *Complete time: 56 seconds . . . a labor saving of 75%.*

This is one reason it is more economical to dispose of corrosive industrial liquid wastes with drainage systems of PVC based on Exon 402-A resin. Installation requires less labor per joint . . . fewer tools and materials . . . and fewer joints.

The new socket type drainage fitting eliminates troublesome corrosion pockets and gives you unimpeded flow conditions. It is unaffected by ground conditions, acid or alkaline, wet or dry. It is not subject to galvanic or electrolytic action.

Exon 402-A is just one resin in industry's most complete line of versatile vinyls. No wonder industry looks to Firestone for engineered answers to its needs.

For resin properties pin-pointed to the best answer to your own plant or product problems, check with Firestone.

Firestone

EXON

RESINS

For complete information and technical service, call or write:

CHEMICAL SALES DIVISION: FIRESTONE PLASTICS COMPANY

DEPT. 76H, POTTSTOWN, PA. • A DIVISION OF THE FIRESTONE TIRE & RUBBER CO.

IN CANADA, CONTACT CHEMICAL SALES DIVISION, FIRESTONE TIRE AND RUBBER COMPANY OF CANADA LTD., HAMILTON, ONT.

INDUSTRY'S MOST COMPLETE LINE OF VINYLS ENGINEERED TO YOUR SPECIFIC NEEDS

Giant LeTourneau Sno-Freighter built on rugged backbone of SHELBY SEAMLESS MECHANICAL TUBING

Another LeTourneau "train," also constructed with Shelby Seamless Mechanical Tubing, maneuvers through the streets of Longview, Texas. The uncovered control car reveals its 3,500-gallon fuel tank and its two diesel engines which generate electricity for driving the wheel motors.

Sno-Freighter in action in northern Alaska. The control cab is 17 feet high; the decks of the cargo carriers are 8½ feet high. Speeds range from 0 to 15 MPH.

The LeTourneau Sno-Freighter is a huge six-section cargo carrier specifically designed to travel over ice, frozen or compacted snow, bull-dozed trails, or rough brush land. It is presently in active use hauling fuel and other strategic materials to radar stations along the Arctic Coast.

The Sno-Freighter "train" consists of a power control car and five cargo cars, each with a capacity of 25 tons. Two 400 H.P. diesel-electric generating sets on the power control car supply electrical power to the 24 drive wheels, each of which has a powerful electric motor tucked into its rim. Thus, each wheel drives independently of the others, making it practically impossible for the carriers to get stuck in sand, snow, or swamp.

All of the Sno-Freighter's car frames are constructed of Shelby Seamless Mechanical Tubing in diameters from 2 inches to 8 inches. In addition, each of the cars is coupled to the one preceding it through a universal joint and a long steel tube of Shelby Seamless. This constitutes the steering mechanism, causing each vehicle automatically to track the car ahead of it. The operator of the Sno-Freighter steers only the two front wheels of the power control car.

There are many good reasons why Shelby Seamless Mechanical Tubing was chosen for the supporting framework of this magnificent mechanical marvel. Primarily, it offers the ultimate in strength and rigidity in proportion to its size and weight. Secondly, it is shock-absorbent, uniform throughout, dimensionally accurate, and possesses excellent machining and superior welding properties. It is produced under rigid standards, and is available in a generous range of diameters, wall thicknesses, various shapes and steel analyses. And it can be fitted to your specifications, regardless of what they are. Contact our engineers. They will be happy to help you adapt Shelby Seamless to your requirements.

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)

COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

SHELBY SEAMLESS MECHANICAL TUBING

TUBES WITHOUT WELDS

UNITED STATES STEEL

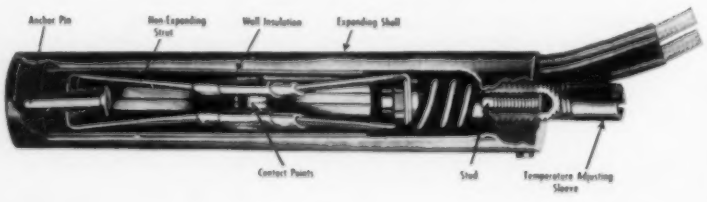
SEE WHY A FENWAL FITS ITS TASK AND

Standard Differential Expansion Units

are tough at the same time they are sensitive. They have these features in common: uniform sensitivity throughout the operating range . . . built-in temperature anticipation . . . enclosed, tamperproof assembly, direct radiant heat reception . . . operating range from −100° F to 600° F.

Midget and Miniature Differential Expansion Units

. . . some no larger than a sugar lump. Actual sizes ¼″ to 2 25/32″ for the Midget, and 1″ x ½″, Miniature. Ideal for "tight spots" where dependability cannot be sacrificed. Hermetically-sealed models. Midget temperature range −50° F to 500° F. Miniature −20° F to 275° F.



Here's How Differential Expansion Units Work . . .

the control element is a single-metal shell that expands or contracts instantaneously with temperature changes, making or breaking the totally-enclosed electrical contacts. The standard size, midget and miniature units all use this principle.

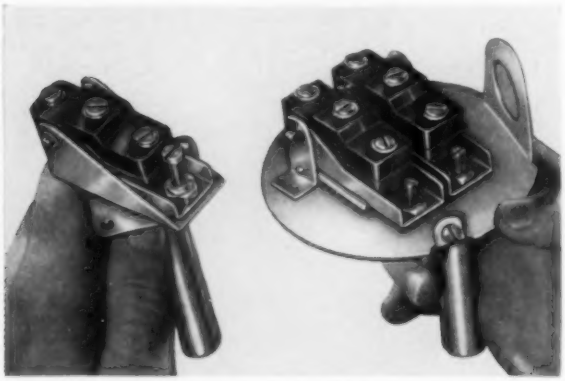
THERMOSWITCH® UNIT YOUR DESIGN SO WELL

Positive-Action Performance in Temperature Control Units in Many Sizes and Shapes

A better answer to many a temperature control situation is to be found on these pages.

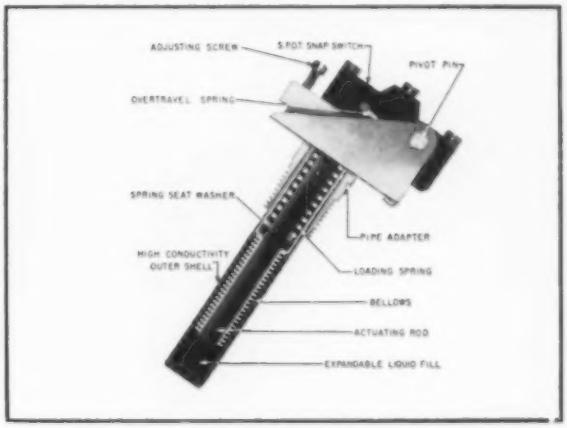
In fact Fenwal can furnish you with over 25,000 variations to satisfy your requirements of temperature range, precise control of set point, physical size and current carrying capacity.

Yes, Fenwal THERMOSWITCH units can provide the answer to your temperature control problems. The coupon will bring you the specific literature that will help you most. **Fenwal Incorporated, Ashland, Mass.**



Snap-Action Units

control loads up to 20 amps, 115-250 volts A.C., or 10 amps, 125 volts D.C. without relays. Picture shows only two of twelve basic models available from Fenwal's Series 20,000 (one switch) and Series 22,000 (two switch) snap-action units. Specialized units can be assembled for you from a selection of temperature ranges, headtypes and mounting styles.



Here's How Snap-Action Units Work . . .

the control action comes from an expandable liquid acting on a bellows assembly which actuates the switch contacts through a push rod. In Fenwal units, the liquid is outside the bellows, adjacent to the shell, for shorter heat transfer path and greater sensitivity.

Fenwal

CONTROLS TEMPERATURE . . . PRECISELY

Fenwal Incorporated
28 Pleasant Street
Ashland, Mass.

Please send me literature and specifications on items checked.

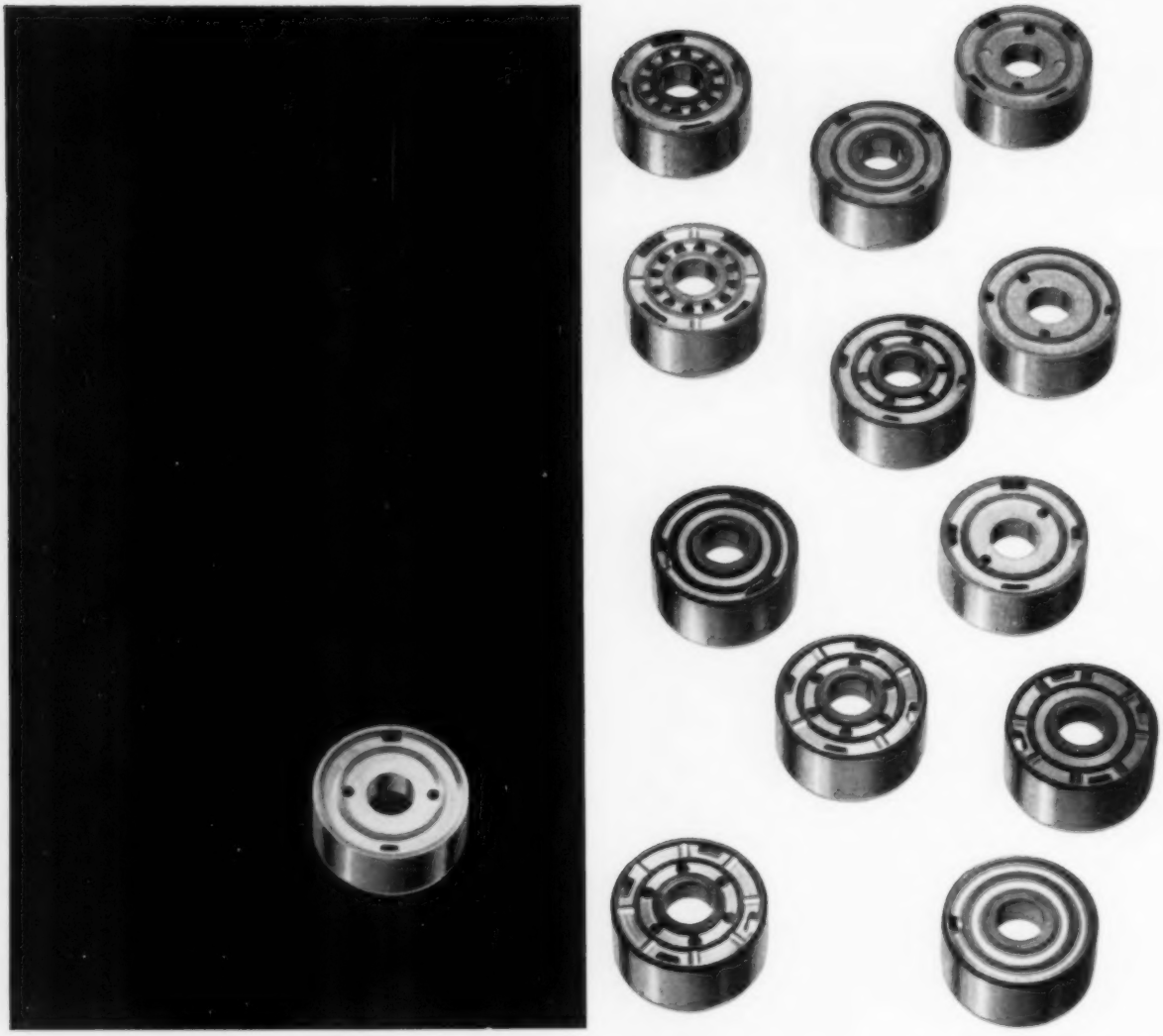
- ☐ Fenwal Standard THERMOSWITCH units (MC-135A)
- ☐ Fenwal Midget and Miniature Controls (MC-124B)
- ☐ Fenwal Snap-Action Temperature Controls (MC-120B and MC-143)

Name .....

Company .....

Street .....

City ..... *Zone* ..... *State* .....



How *small* can variations be in metal powder parts?

The metal powder shock absorber piston on the left is a basic design. Hundreds of thousands exactly like it are made every year. Those on the right match it precisely—in diameter and length. And they, too, are made in vast numbers. But each one has its own variations, as examination will show, to suit it to the weight and ride characteristics of a particular vehicle. Regardless of the similarity or variation, all of these parts are made inexpensively of metal powder with no machining and no wasted stock. In every case, closer-than-ever tolerances are maintained.

Moraine Products also produces: Moraine Power Brakes—Delco hydraulic brake fluids, brake assemblies, master cylinders, wheel cylinders, and parts—Moraine friction materials—Moraine-400 and M-100 automotive engine bearings—self-lubricating bearings and porous metal filters—rolled bronze and bi-metal bushings.

Another General Motors Value

Moraine Products
Division of General Motors, Dayton, Ohio

DU PONT
REG. U.S. PAT. OFF.
Better Things for Better Living
. . . through Chemistry

PRODUCT ENGINEERING NEWS

LATEST PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: ZYTEL®, TEFLON®, LUCITE®

Tough, wear-resistant bearings of ZYTEL® nylon resin outperform conventional materials in helicopter rotor

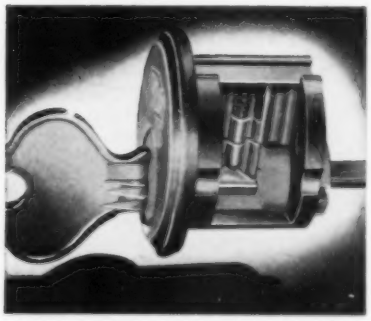
"This application has solved all spar-tube galling problems," reports the Rotor Group Engineer at Doman Helicopters, Inc. "By eliminating galling problems in the Doman Rotor, there is no longer a need for field maintenance of the blade-retention system."

The application: a liner of ZYTEL nylon resin in the main rotor-blade bearing packs which support spar tubes in the arm of the rotor hub. The use of ZYTEL solved a problem of fretting corrosion which destroyed other sleeve bearings.

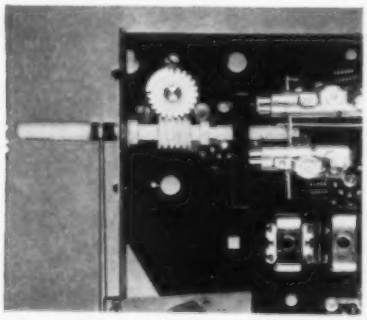
The excellent bearing characteristics and toughness of ZYTEL solved this engineering design problem. Other desirable mechanical properties include ease of fabrication by molding or machining from stock, strength in thin sections and resistance to impact.

Many uses of ZYTEL are based also on its good electrical insulating properties. ZYTEL nylon resin is rated for intermittent operation up to 250°F.; for continuous operation at such elevated temperatures, heat-stabilized grades are available. ZYTEL resists the action of many common chemicals. Because of the low-friction characteristics and resiliency of ZYTEL nylon resin, gears, cams and bearings operate quietly, with little or no lubrication. Complicated shapes can be molded to precise dimensions around inserts.

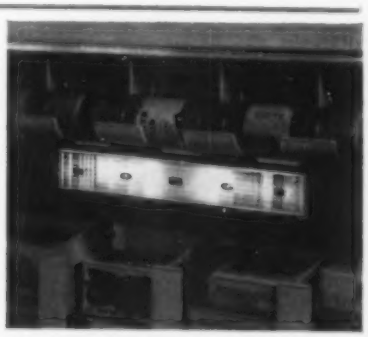
SLEEVE BEARING of ZYTEL supports spar tube in the arm of helicopter rotor hub. Bearing is 2" in diameter, 6" in length. Toughness of ZYTEL enables it to outperform other bearings. Spar-tube life is extended, maintenance reduced. (Made by Doman Helicopters, Inc., Danbury, Connecticut.)



CYLINDER PLUG for door lock is molded of Du Pont ZYTEL nylon resin. Cylinder lubrication is not necessary because of the low coefficient of friction of ZYTEL. The cylinder plug does not stick and turns smoothly in the lock. Unlike certain metals, the cylinder plug is corrosion-resistant and weatherproof and is not subject to electrolytic action. The hardness, durability and the abrasion resistance of ZYTEL nylon resin help insure against wear, and provide long service life for all parts molded of ZYTEL. (Door lock manufactured by The Taylor Lock Company, Philadelphia, Pennsylvania.)



INTRICATE TUNING SHAFT for radio selector mechanism is precision-molded of ZYTEL nylon resin. The shaft needs no lubrication yet operates easily. It is non-magnetic and has high electrical resistance. Stiffness and torsional strength are more than adequate. Shaft has integrally molded gears, washers, holes, bevel and step. Considerable savings in fabrication costs over metal were realized. Components of ZYTEL nylon resin usually need no further finishing after molding. (Molded by Engineered Nylon Products, South Bend, Indiana, for Granco Products, Long Island City, New York.)



ILLUMINATOR LENS made of Du Pont LUCITE® acrylic resin distributes soft, even light throughout the interior of the new Norge Home Freezer. Located in the door, the lens also serves as an attractive name plate. Du Pont LUCITE is strong and tough . . . has remarkable optical properties, transmitting 92% of impinging light. LUCITE has high resistance to shattering . . . good dimensional stability. (Lens molded by Stimsonite, Division of Elastic Stop Nut Corporation of America, Chicago, Illinois; Freezer by Norge Sales Corporation, Chicago, Illinois.)

OVER

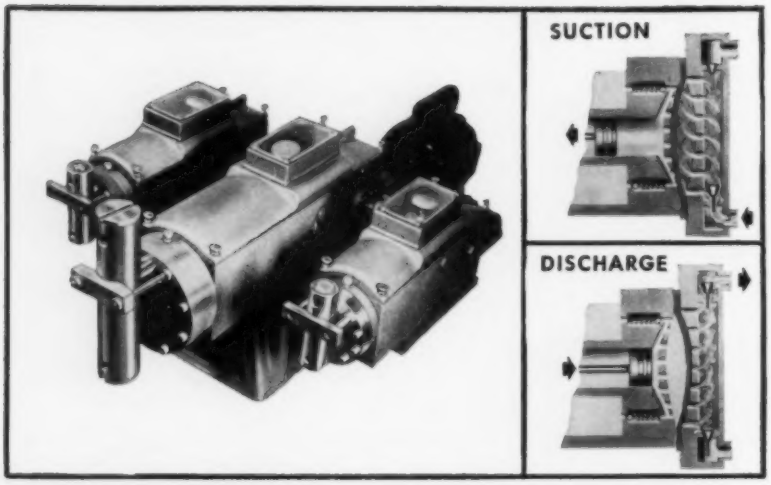
DU PONT
Better Things for Better Living . . . through Chemistry

PRODUCT ENGINEERING NEWS

LATEST PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: ZYTEL®, TEFLON®, LUCITE®

No. 3, 1957

Chemical inertness, high flex strength of TEFLON® resins are featured in pumps handling powerful corrosives



"PULSAFEEDER" DIAPHRAGM PUMP employs a tough, flexible diaphragm of a chemically inert TEFLON tetrafluoroethylene resin. Model shown is a triplex assembly used in handling hydrogen peroxide, sodium hydroxide and sodium silicate for bleaching fabrics. (Flexible diaphragm of TEFLON trademarked Fluorlastic by the Joclin Manufacturing Company, Wallingford, Connecticut; pump by Lapp Process Equipment Division of the Lapp Insulator Company, Inc., Leroy 6, New York.)

The Lapp "Pulsafeeder" can be used as a metering pump or as a proportioner, pumping two or more liquids in an established ratio. In the case of highly corrosive fluids, it depends on tough, flexible diaphragms of a TEFLON tetrafluoroethylene resin for resistance to chemical attack plus high strength.

On the piston side of the diaphragm, TEFLON tetrafluoroethylene resins are unaffected by any type of oil used as the hydraulic activating medium. On the pumpage side, TEFLON resins are completely inert to acids, aliphatics, aromatics, chlorinated hydrocarbons, alkalies and, in fact, almost any chemical or solvent in commercial use. The few exceptions to this include attack by the alkali metals under certain conditions. At high temperatures and pressures, halogens and certain halogenated chemicals and solvents may also affect TEFLON. TEFLON is rated for use to 500°F. and does not become brittle even at temperatures near absolute zero.

TEFLON 1, TEFLON 5 and TEFLON 6 resins may be used to make durable components such as seals, gaskets, packings and bearings. They are superb dielectrics.

The properties of TEFLON resins may have application in one of your own designs. Mail the coupon for a full report on uses and characteristics.

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept.
Room 136, Du Pont Building, Wilmington 98, Delaware

Please send me more information on the Du Pont engineering materials checked: ☐ *ZYTEL;* ☐ *TEFLON;* ☐ *LUCITE. I am interested in evaluating these materials for:*

_____

*Name*_____

*Company*_____ *Position*_____

*Street*_____

*City*_____ *State*_____

*Type of Business*_____

IN CANADA: Du Pont Company of Canada(1956) Limited, P. O. Box 660, Montreal, Quebec.

SEND FOR INFORMATION

For additional property and application data on LUCITE® acrylic resin, TEFLON® tetrafluoroethylene resins and ZYTEL® nylon resin, mail coupon.

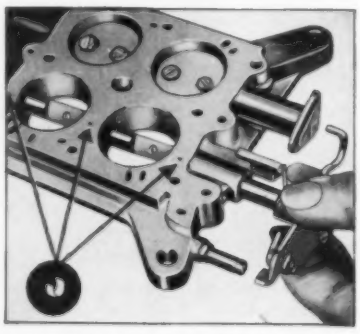
Thin-walled tubing of TEFLON® resins withstand soldering temperature, simplify assembly

TEFLON tetrafluoroethylene resins maintain high dielectric strength at elevated temperatures. They also have high surface resistivity, dropping only to 10^{13} ohms at 100% relative humidity. TEFLON maintains full electrical insulating characteristics, even when flexed or bent during assembly and installation. This combination makes it possible to miniaturize an electrical assembly without fear of dielectric failure.

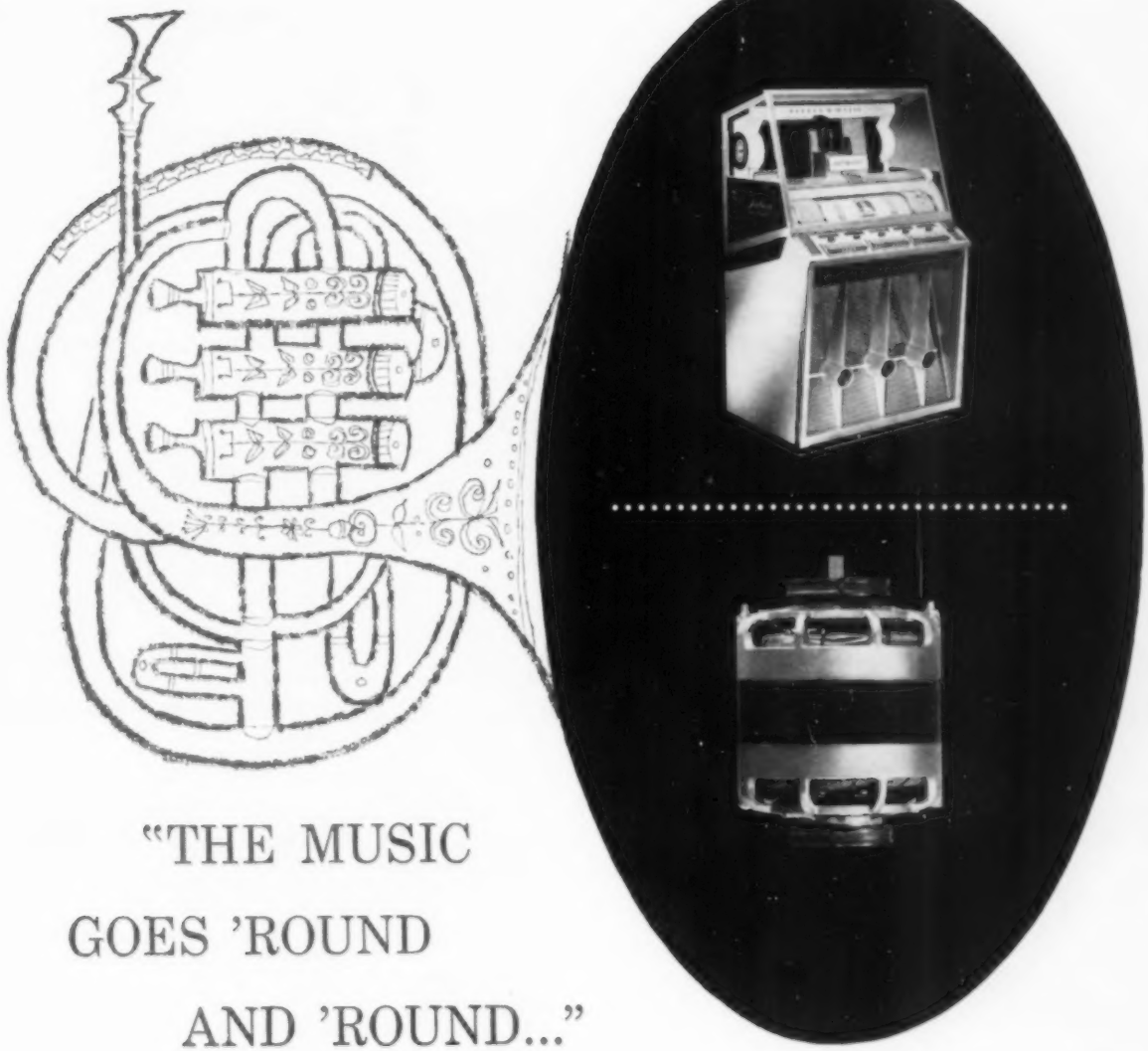
For example, thin-wall tubing of a TEFLON resin simplifies assembly of component parts in a series of miniature rotary tap switches. Since TEFLON resins will not burn, melt or decompose when connections next to them are soldered, assembly of switch parts is easier, faster, and the possibility of accidental grounding is minimized. The thermal stability of TEFLON resins, even in thin sections, is demonstrated in this tubing where the wall thickness is only .014". The nominal inside diameter is .075". TEFLON resins meet Class H, AIEE standards for maximum insulating temperatures.

TEFLON resins are non-flammable, have good mechanical strength and are completely unaffected by sunlight or outdoor weathering. They have zero water absorption by ASTM test D570-42, resist corrosion and growth of fungus, are chemically inert.

Carburetor bearing problem solved with TEFLON® resins



Carburetor bearings of a TEFLON resin are used on the secondary throttle shaft of carburetors in all 1957 models of two popular cars. "Self-lubricating" property of TEFLON eliminated a serious problem of slip-stick action of the shaft caused by gums in gasoline. The use of carburetor bearings of TEFLON eliminated the necessity for chrome-plating the shafts. Top product performance is assured, at decreased manufacturing costs. (Carburetor by Holley Carburetor Company, Van Dyke, Michigan; bearings by Modern Industrial Plastics, Inc., Dayton, Ohio.)



"THE MUSIC GOES 'ROUND AND 'ROUND..."

ON 34-FRAME MOTORS BY WESTINGHOUSE

LET 'EM "POWER-UP" YOUR PROFITS TOO!

Whenever you're "out on the town" and hear the music goin' round and round, it's a pretty good bet you're listening to a Seeburg machine. For Seeburg is America's No. 1 manufacturer of commercial phonographs . . . all powered by 34-frame motors by Westinghouse.

The Westinghouse 34-frame induction motor is designed specifically for business machines—electric typewriters, movie projectors, "jukeboxes", tape recorders, adding machines and a wide range of office equipment. The 34-frame offers outstanding power-to-weight ratio, no radio or TV interference, light weight, quiet operation and amazing dependability. *And* the 34-frame is versatile—it can be tailored to your *specific* requirements. Just look at these features . . .

Housing—Precision die-cast aluminum brackets assembled to machined fits for sturdy construction and light weight.

Bearings—Self-aligning bronze bearings for economy, less maintenance, and long, *quiet* operation. J-03037

Mounting—Supplied with resilient mounting rings for assembly into your base or with complete base. Motors can be mounted in any position.

Whatever your particular requirements, Westinghouse engineers will help you select exactly the right motor. Interested? Just fill out the coupon below for additional information . . .

YOU CAN BE SURE...IF IT'S Westinghouse

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Westinghouse Electric Corporation
Small Motor Division, P. O. Box 566
Lima, Ohio

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TITLE _____

COMPANY _____

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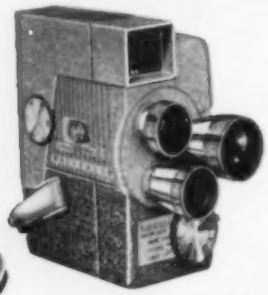
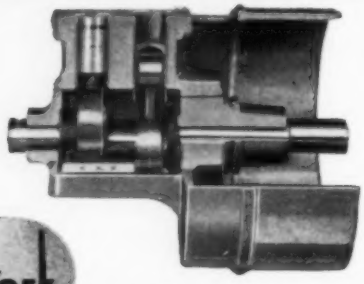
CITY _____ ZONE ____ STATE _____



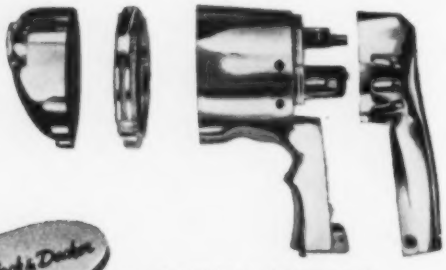
Revere

. . . makes camera parts *light-tight* and *interchangeable*



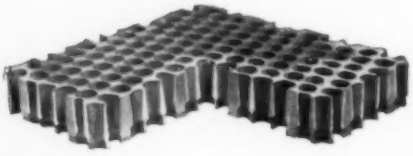
York

. . . combines motor and compressor into *one-piece* housing



Black & Decker

. . . cuts finishing of power tools to *one buffing* operation



E.W. Blatchford

. . . makes "Honeycomb" printing base in *only way* it could be done

Regina

. . . concentrates *weight where needed* in floor waxer

Sunbeam

. . . closely *matches section thicknesses* to strength requirements of appliances

A dozen blue-chip products Doehler-Jarvis die-

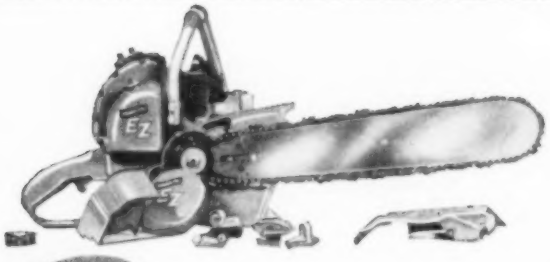
Each of these twelve products is outstanding in design.

One is extra light. Another is unique for precision. A third is remarkable for space economy. Each has a key feature that helps make it a success.

All these patterns of success are variations on a single theme . . . the skillful use of Doehler-Jarvis die castings to achieve design objectives.

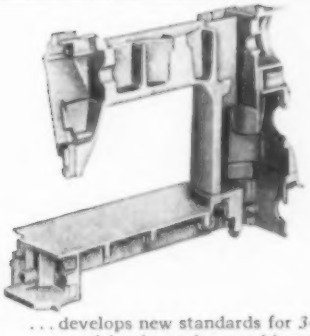
In each case, the manufacturer brought Doehler-Jarvis into the design picture at an early stage. Customer and D-J engineers worked out the specifics . . . the basic contours, the section, the coring, the ribbing, the ejection lugs, machining base points, finish . . . all the fine points.

Design results have been enviable. And frequently there have been important side benefits . . . metal saved, machining and assembly operations by-passed, finishing steps reduced, rejects prevented.



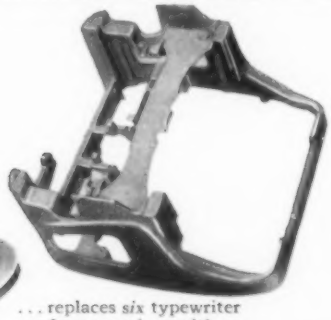
HOMELITE

. . . packs 5 horsepower into chain saw weighing *only 19 pounds*



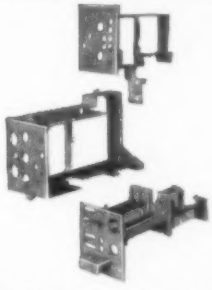
SINGER

. . . develops new standards for *3-dimensional* precision in sewing machine assemblies



Underwood

. . . replaces *six* typewriter frame castings with *one*

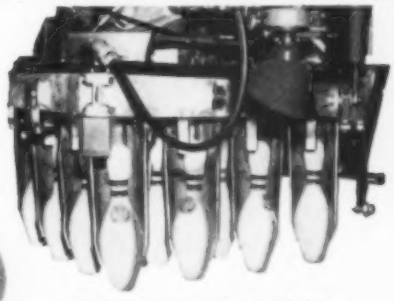


Western Electric

. . . makes *one* unit of space do the work of *six* in telephone terminal equipment

Sears Roebuck

. . . designs mower housing for *built-in assembly savings*



AMF

. . . *eliminates nearly all machining* in 99 pinspotter parts

illustrate a dozen ways castings improve product design

Take your cue from the makers of these successful products

If you're looking for ways to improve your product, lower its cost, or speed its production . . . or if you're developing new devices . . . do what the makers of the products shown above did. Call in Doehler-Jarvis.

We'll be glad to help you evaluate the possibilities for you in die castings.

Doehler-Jarvis

DIVISION OF NATIONAL LEAD COMPANY

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TRADE MARK

MULTI-FLEX

A Versatile Line of Boots, Connectors, Bellows, Tubes, Air Ducts

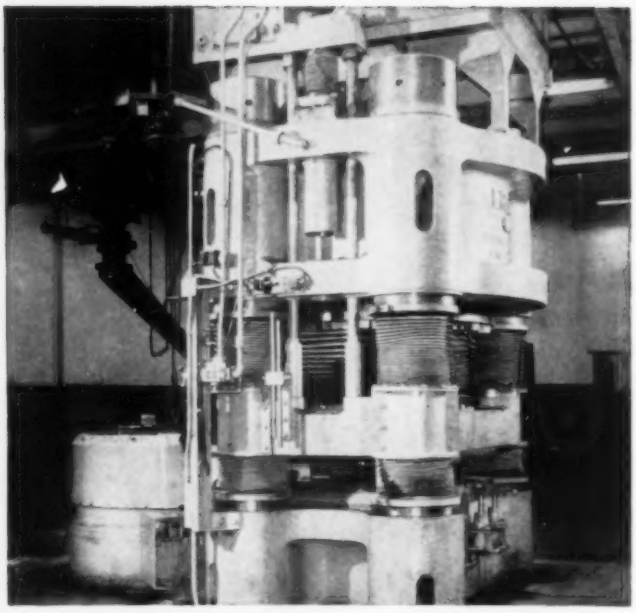
If the equipment you make requires

- accordion protective boots
- connectors to take bends or movements in compression or extension
- bellows to move air or be actuated by air
- extremely flexible tubing that will not kink

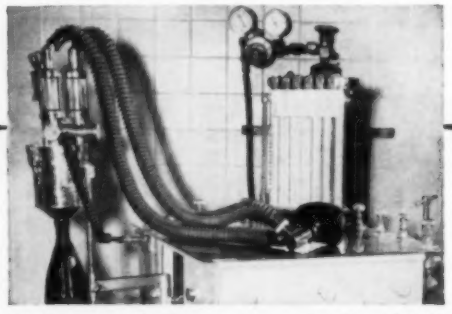
you'll do well to investigate U.S. Multi-Flex.®

Made circumferentially corrugated without molds or other tooling, in inside diameters ranging from ¼" to 48", and engineered to your particular requirements, these products may furnish the answer to difficult-to-solve application problems.

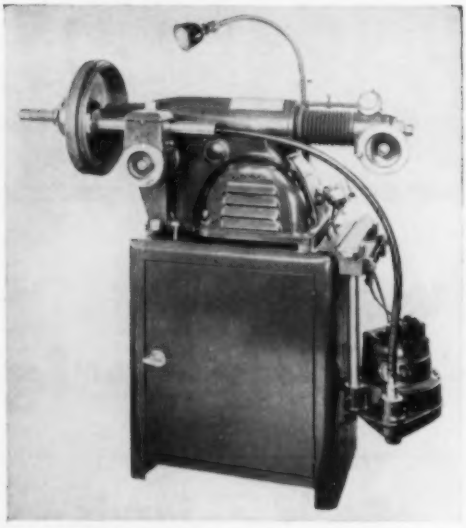
Get U.S. Multi-Flex, plus expert engineering service, at any of the 28 "U.S." District Sales Offices, at selected distributors, or by writing us at Rockefeller Center, New York 20, N. Y. In Canada, Dominion Rubber Co., Ltd.



Multi-Flex laced boots keep dirt and grit out of hydraulic rams. They are laced for easy installation without dismantling press.



Multi-Flex conductive tube—extra-flexible and lightweight—in use on anesthesia equipment.



Multi-Flex boots giving constant protection to the shaft on this brake drum lathe.

Multi-Flex connectors on vacuum filter, taking care of axial movement and misalignment.

Mechanical Goods Division

United States Rubber

PERSPECTIVES

in design and development . . .

Automation In Electronics is Bunk

"It is a curious fact that business people who do a great deal of advertising, and therefore should be somewhat skeptical when they read other people's advertisements, are by nature just as trusting and gullible as the rest of the public. It is not surprising, then, that catch words like 'automation' have gotten such a hold on the manufacturing public, and that fashion in the past ten years has often replaced hard engineering logic. Since electronics plays an important part in making production more automatic, this industry itself has been seriously bitten by the bug. It is my opinion that in the electronics industry, most of the automation attempted so far has been bunk."

And with that charge, Mr. Jacob Rabinow, President, Rabinow Engineering Co., Washington, D. C., proceeded to cite chapter and verse on the mistakes that have been made in bringing automation to the electronics industry. The occasion for his talk was the First National Symposium on Production Techniques held the 6th and 7th of this month in Washington. D. C.

Product Wiring Not Expensive

"Take, for example the case of mechanized wiring systems, printed circuits, etched wiring, and so on," continued Mr. Rabinow. "The wiring of a radio or television set never has been a very large part of the total cost. The total labor cost of constructing a television set, which includes assembling, wiring, testing, troubleshooting, boxing, and so on, has been of the order of $4 for a table model. Of this, perhaps, a dollar or so was the cost of wiring. If it is possible to save even a small part of this by spending several million dollars for automatic equipment, then it is necessary to produce a very large number of receivers before the machinery can be amortized. Considering the rapid changes in the electronic industry, it is doubtful that this makes any sense.

Product More Uniform?

"Another argument for automatic wiring is that the product is better, and more uniform. Again, I do not think that is so. Hand wiring of the conventional variety produces as good a product as the present printed circuits, and with the most elementary equipment. In many of the dip soldering techniques, the joints are rather flimsy, the leads being held by an uncertain solder bridge. In those cases where the leads are crimped, or otherwise mechanically anchored, the problem is less serious.

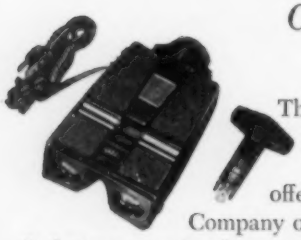
"In automatic wiring, particularly with dip soldering techniques, the preheating of the panel, chemical control of the solder, the temperatures, the nature and application of the flux, washing, and so on, all are jobs requiring precise control. Machinery to do this is very expensive, and the operators of the machinery have to be of a higher grade than the people who used to do the soldering directly. Furthermore, in many of the automatic techniques, the amount of solder used is much greater than that needed in hand soldering.

"The cost of most mass produced articles is basically established by the amount of material consumed, and the amount of insulation per wire in a printed or etched circuit is invariably greater than in ordinary wiring. This means that the ultimate cost must remain high unless very cheap insulating materials can be produced. Because good insulation is necessary

(Continued on page 129)

Big News in Stereo Viewers

Chicago Molded uses phenolic of top dimensional stability



The new, prestige-building Realist Stereo Viewer at the left is now being offered by the David White Company of Milwaukee, Wisconsin.

It features: optional power for illumination – *either from a light socket or battery;* knob-easy brightness control; a new focusing adjuster; a thumb wheel interocular adjuster that permits each viewer to set the proper distance between eyes.

The viewer is making big news in plastics, too! The eleven parts you see above are all custom molded. For top dimensional stability so vital in precision optical equipment, Chicago Molded has used an improved, compression molded phenolic that is highly impact resistant. For sales appeal and quick product identification six parts are a sprightly green polystyrene. For production economy, all six have been injection molded at one time in a six-cavity mold.

Whatever your new product needs, you'll find *it pays* to call in Chicago Molded. CMPC engineers keep abreast of developments in plastics to help you make your product more saleable, yet less costly. *That's why 60% of our business comes from firms we've served for over 15 years.*

Write today for a free subscription to *Plastics Progress,* Chicago Molded's data packed magazine on up-to-date developments in plastics.

CHICAGO MOLDED PRODUCTS CORP.
1032 North Kolmar Avenue, Chicago 51, Illinois

to keep leakage low, particularly where the wires are so close together, it is doubtful that the cost of insulation will ever come down to that which is now being used on individual wires. Furthermore, two-dimensional wiring puts the designer into a topological straight jacket.

Product Appearance

"In terms of appearance, printed or etched wiring does have an advantage, and this may be of sufficient value to salespeople to compensate for some of the disadvantages. And, when "printed" circuits combine a mechanical function also, they do a superb job. For the production of special commutators, switches, integral plugs, identification marks, terminal boards, and integral inductors and capacitors, the use of photographic and other mechanized techniques has no equal.

"In computers where many identical elements have to be replaced easily and where the cost of wiring is not a major consideration, printed boards which provide their own terminals and become plug-in elements are very attractive. Also, a computer is very often designed and built by laboratories who do not need large staffs of wiring operators, and there is the tendency to farm out the printed circuit to companies specializing in this work. They prepare the layouts and manufacture the printed boards. The cost of a 3 x 3 in. board is about $4 in small quantities. This would be ridiculous by radio standards, but is acceptable to the computer people, since much of this type of work is done for the government, and there is no real incentive to cut costs.

"The present effort to stretch our technical abilities leads to a dilution of effort in many ways. The farming out of the wiring of electronic components is one of them. It apparently is easier to pass the job on to a specialist who works in a magic field like etched circuits, than if he were engaged in conventional wiring, although I see no reason why specialists could not do this also.

Automating the Trivial

"The military and other agencies of the government have done a great deal of pioneering in automatic wiring. There is a famous project called Project Tinkertoy, which was carried on at the National Bureau of Standards, that was instrumental in promoting the completely automatic assembly and wiring of electronic circuits. This project was later taken over by industry. My feeling about that particular project is that it was 'automating the trivial.'

"This machine not only wired the components, but manufactured them as well. The components it made were the inexpensive resistors and small capacitors, while the larger and more complicated elements were purchased outside. Such an approach does not make sense, for history has shown that costs of a product are brought down because the maker can supply many customers. A manufacturer of radio sets hardly can take the position that he should make his own inexpensive components. His demands are much too varied.

"I was told by an engineer of a company in the module business that they could make their own resistors cheaper than they could buy them. This does not sound plausible, for if it is so, then the resistor is of inferior quality, or the process is a technological breakthrough. If the latter is the case, then the people who make resistors will copy that approach and again beat the manufacturer of the complete assembly at his own game.

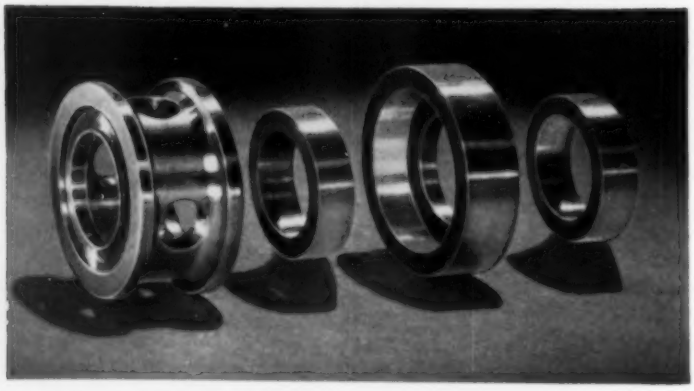
"Another disadvantage of the Project Tinkertoy development is that

(Continued on page 131)

SINGLE BUSHING TYPE Floating Ring Seal

Seal Any Medium—Even Corrosive Media . . . with Koppers Floating Ring Seal

MULTIPLE RING TYPE Floating Ring Seal (assembled)



FLOATING RING SEAL Basic Elements: Lantern Ring, Floating Ring, and Spacer Diaphragm. As sealing needs dictate, floating rings and spacer diaphragms are added. Seals are carbon, plastics, ceramics or steel, as applications require.

The Only "No Maintenance" Seal for Rotating, Oscillating and Reciprocating Motion

Koppers' precise, efficient Floating Ring Seal assures long seal life, low leakage, reduced wear, less power consumption, and decreased operating costs.

It seals at high temperatures and at pressures up to, and for some conditions even above, 2000 psi. Inspection has shown that after 10,000 hours of operation, ring and spindle wear can be negligible. For water at 500° F. and 1200 psig with a 5/8" spindle, leakage is only one to two pounds per hour. Frictional power requirements are virtually zero, and Koppers' design reduces radial frictional restraint. Sealing members adapt to changes in the shaft's position.

Applicable to valve spindles, pumps, atomic reactor spindles and many other similar installations, Koppers Floating Ring Seal gives efficient, low-cost service for the sealing of all types of fluids under widely varying conditions of temperature and pressure.

For additional information, write to: KOPPERS COMPANY, INC., Piston Ring and Seal Department, 7306 Hamburg Street, Baltimore 3, Maryland.

KOPPERS

MECHANICAL SHAFT SEALS

Engineered Products sold with *Service*

the design was so rigid that changes were difficult to make. The space alloted in that particular design made it obsolete for transistorized equipment as soon as it was announced.

Military Sold Bill of Goods

"The military also have been sold a bill of goods about how easy it will be to put automated electronic equipment into production. The story is that we can prepare a factory, put everything under wraps after all the machinery has been adjusted, and in case of war all we have to do is throw a switch to cause electronic components to start pouring out. This is a childish dream. Just look at the history of electronics. For instance, when the second World War broke out, we had to develop new tubes, new components, and new techniques, not only for radar (for which there was no precedent), but for things like proximity fuzes, and other new devices. We certainly could not have used any factory mothballed in the early thirties. For the present, think only of transistors, magnetic, and ferroelectric devices. To mothball factories today we would have to assume that electronic progress had stopped. This would be the height of vanity.

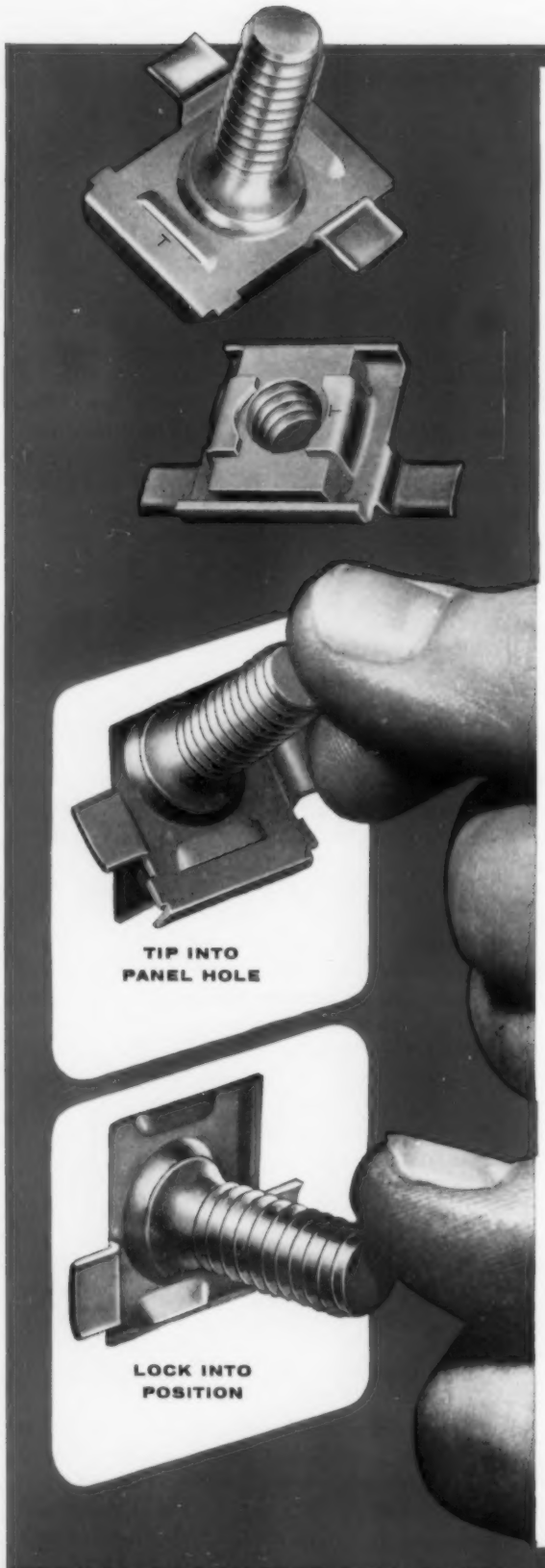
On Modular Construction

"The advantages of modular construction are being promoted. The argument is that instead of building electronic equipment of individual components, the equipment should be designed to be made up of little subassemblies so that repair in the field can be done simply by pulling out a subassembly and plugging in a new one. Experience shows that this is a dangerous approach. The total number of combinations of these components in possible subassemblies is almost infinite. One has to be an optimist to believe that these assemblies will be available when and where they are needed.

"There are two practical ways of attacking the in-the-field service problem during war: one is to use standard basic components and to have a stock of these on hand, and to use common identifications for them. This, the services are doing now, so that a one ohm resistor is a one ohm resistor no matter which piece of equipment will use it. The other approach is to make the whole piece of equipment so inexpensive that it can be discarded as a unit. During the war this approach was more the rule than the exception, even though the equipment was not designed to be thrown away. There was not enough time nor the skill to repair it, and often excellent equipment was treated as expendable.

"This does not mean that modular design cannot be used where it might be profitable, but it should not be used as an argument that replacements will be cheap or easy. Some of the present printed circuits on ceramic plates are more than competitive with conventional components. Repairing these plates is almost impossible, so they must be replaced as units. This means that large stocks of these must be carried by dealers, and these stocks will continue to grow. However, even if the cost of these assemblies can be made financially attractive for household equipment, before they can be used in military products they must be studied carefully.

"My experience with the proximity fuze is that if the equipment is designed for a one-shot operation, and made so that it cannot be opened and repaired, it is possible to get a much better product. First of all, it requires each component to be tested before it goes in, and secondly, that the equipment can be so rugged as a result that it ends up as a much improved product. Considerable savings are possible too by eliminating all accessibility." —PAUL ANDERSON



Blind assembly costs cut in half with SPEED GRIP® Bolt and Nut Retainers

A tip-in . . . a sidewise pull . . . and this new front-mounting SPEED GRIP Bolt and Nut Retainer is locked in the panel without special tools or skills.

The exclusive SPEED GRIP locking feature provides enough lateral drift to compensate for normal production misalignment of the parts to be fastened together.

Blind-panel assemblies no longer require awkward, time-consuming acrobatics for fastening. The problems caused by damaged threads in welded, staked, or clinched fasteners are eliminated. SPEED GRIPS can be slipped into place anywhere on the production line.

These convenient, time-saving SPEED GRIPS are available to fasten a wide range of unit sizes and bolt diameters to a variety of panel thicknesses. Ask your Tinnerman representative for samples and engineering data. All major telephone directories list your closest Tinnerman Sales Engineer. Or write to

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TINNERMAN
Speed Nuts®

FASTEST THING IN FASTENINGS®

Rubber-band Mind

What is a design engineer? Last December, a member of the Institution of Engineering Designers, London, offered this definition:

One who professionally defines practical forms or arrangements within given circumstances which will fulfill functions necessary to solve specific engineering problems.

Subsequent discussion brought out that this was too vague, could cover shop men or locomotive engineers as well. So a second definition was offered:

A professional person who by original or modified processes of thought fulfills specific engineering requirements.

This was considered too indefinite still; it failed to suggest that the objective was a physical object; like its predecessor it failed to define "engineering." These objections led to a third try:

One who prepares the necessary technical instructions for the purpose of directing the great sources of power in nature for the use and convenience of man.

This was considered "indeed a glorious definition,"* but there were those who challenged it as well. One asked whether the designer of a spoon is a design engineer. It was ultimately decided that he is not—unless he designs the spoon for mass production.

Ultimately the meeting broke up, with a universally acceptable definition not yet developed. But the first speaker of the evening had actually come the closest of all. He had said: "I suggest that the first step is to think of the brain as a rubber band. It must be compelled to stretch out in many directions for answers to a design problem. A good way to tackle any design problem is to write down the known facts of the assignment to form a core, and then think outwards until the core is surrounded by a series of spokes—each an idea for further consideration."

He had put his finger on the essential problem, that of escaping the dangers of thinking in one direction only. He went on to describe the need for emotional balance, objectivity unswayed by personal preference or argument, clear recording of every applicable idea. But his summation was the clincher:

The design engineer is an engineer with a "rubber-band mind." He will swarm all over a problem, exploring every facet. He will make quick decisions based on experience and information gathered, but he will be able to switch to the abstract thinking by which sweeping ideas are born.

We respectfully suggest this to our London contemporaries as the most lucid definition of their evening.

* *It actually paraphrases a definition that is more than a hundred years old. Said Thomas Tredgold in 1828: "Engineering is the art of directing the great sources of power in nature for the use and convenience of man."*

L. J. Langman

FACTS

about

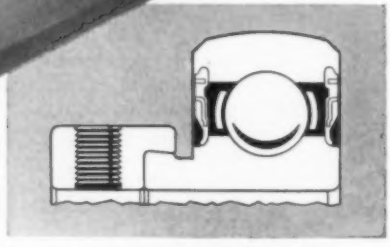
NEW DEPARTURE BALL BEARINGS

NOW A NEW DEPARTURE IN PILLOW BLOCKS

- Clean, rigid, compact design.
- Free of any lubricating fixtures.
- New Departure ball bearings sealed and lubricated-for-life.
- Pillow Blocks easily mounted without special tools.
- Only high capacity precision ball bearings used.
- Accommodates any misalignment.
- 31 shaft sizes, ½" through 2 7/16".
- Interchangeable with most makes.

Send for Catalog PBC for complete details.

GREASE SEALED IN
DIRT SEALED OUT
with
FAMOUS SENTRI-SEAL



The bearings are easily applied to the shafting and are positively locked in position with an eccentric cam locking collar and set screw.

New Departure Pillow Blocks employ the performance-proved New Departure Type AE Adapter ball bearings with spherical O.D. for alignability and steel-reinforced Sentri-Seals for long life protection against dirt or grease leakage.

BALL BEARINGS MAKE GOOD PRODUCTS BETTER

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

EPOXY CASTINGS

—lower cost alternative to metal or molded plastics for limited quantities of complex parts.

Advantages of epoxies; how to design large parts—hardener systems, mold design, coring, parting agents, curing cycles, applications and costs.

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New Products Laboratory
Leeds and Northrup Co.

RELATIVELY large and complex cast resin parts can be made with minimum tool expense and without costly molding equipment. Even if molding facilities are available, low set-up cost for these castings may save expense on short runs.

Certain resin materials—epoxy, phenolic, polyester and silicone—can be compounded to polymerize without pressure, and thus can be cast in open molds. Each of these types have comparable physical and mechanical properties, but the epoxy resins are the easiest to handle. Epoxy castings also have low shrinkage and low residual stresses, good chemical resistance and high dielectric strength, although cost is higher and transparency is limited. For a detailed discussion of these advantages and limitations see Table I on the following page.

Epoxy casting resins are available with two principal types of hardener systems: acid hardeners in heat curing formulations and amine hardeners in room-temperature curing resins. Acid-hardened systems are usually made up of two solids which must be melted, mixed, poured when hot and cured at an elevated temperature. As shown in Fig. 1, temperature rise is gradual for this system, making it ideal for casting large crack-free parts. Amine-hardened systems with short-time exothermic peaks are ideal for embedding electronic components

TABLE I—CHARACTERISTICS OF CASTING RESINS

Characteristic	For All Casting Resins	For Epoxies
Curing Required	Casting resins are low-molecular-weight monomers in liquid or granular form which require further polymerization to reach the strong solid state. This is usually done by external heat in the presence of a catalyst or hardener to speed the reaction. The term "hardener" is generally used with epoxies; "catalyst" with polyesters, phenolics, acrylics and others.	Simple to prepare. A typical epoxy formula might be: 4 parts by weight base resin, 1 part hardener; an equivalent polyester formula: 100% by weight base resin, 1% catalyst, 3% cobalt dryer, 1% accelerator. Many epoxy resin-hardener combinations are supplied by compounders in granule form.
Exothermic Action	During cure most resins give off heat. The degree of exothermic action can be controlled by selection of catalyst or hardener. With room temperature cured resins, the exothermic action itself supplies heat necessary for polymerization.	Low exothermic action. Temperature rise can be controlled in large epoxy castings by choosing an acid hardener instead of an amine hardener. Cure time is longer, but danger of cracking is minimized. Typical exotherms for epoxy casting resins are shown in Fig. 1.
Shrinkage	Mass and density changes during curing cause shrinkage, which can vary from a low of 0.25% to a high of 12%. (Certain resins swell or remain constant in size). Shrinkage is primarily a resin characteristic, but can be controlled within limits by use of fillers and choice of catalyst. The greater the exothermic action the greater the shrinkage, often causing cracking.	Low shrinkage. Epoxies with shrinkages as low as 0.004 in./in. or less are available. Normal shrinkage for epoxies is about 0.015 in./in., about half that of other common casting resins. This low shrinkage is of advantage where delicate components are encapsulated or where hollow castings are to be made.
Residual Stresses	When shrinkage occurs during the hardening stage, internal stresses are set up around re-entrant corners, inserts, cores and at points where release from the mold is poor. Residual stresses can be minimized by choosing a long cure cycle system, by post anneal of the casting, or by adding plasticizers.	Low residual stress level. Stresses are low because of low shrinkage and the slightly plastic character of the cured material at elevated temperatures, which permits stress relief by annealing. Threads are usually severe stress raisers; in castings, however, both female and male threads can be easily cast, using split molds for the latter.
Viscosity	Mold surface reproduction depends upon resin viscosity, which can vary from that of molasses to that of water. A resin with low viscosity will flow into small mold indentations, and will permit air entrapped during pouring to escape easily. To prevent voids in the casting, air bubbles must be removed before gelation begins. With viscous resins, the mold must be evacuated to facilitate bubble removal.	Wide viscosity range. Pouring viscosities vary from paste to water thinness. Ideal viscosity is that which will permit air bubbles, entrapped during pour, to rise to the surface before gellation. Many epoxy formulations meet this requirement.
Cure Time	A resin system is cured on a basis of time and temperature. With a versatile resin, cure time may be varied from a few minutes to many days by selection of catalyst, cure temperature and filler. For economy, a minimum cure time is essential; however, a compromise must be struck between this factor and shrinkage cracking. Because plastics are good thermal insulators, larger parts require longer curing cycles to avoid thermal cracks.	Many cure times possible. Epoxy resins selected for particular physical properties can be cast using a variety of curing cycles, from a few seconds to several hours in length. Amine-cured epoxies cure faster than those with acid hardener, but have sharper exotherms.
Shelf Life	Gradual polymerization begins as soon as a resin is manufactured, a process analogous to age hardening of certain alloys. If a resin batch is not fresh, addition of the catalyst in an established cure cycle may cause premature gellation, making the mix impossible to handle. Retardants are available to extend shelf life, however.	Long shelf life. This factor is important in reducing material waste. Epoxies with shelf lives up to several years are available, whereas with polyesters about 1 year is maximum. Pot life (maximum handling time after catalysis) varies from 30 minutes to 7 days.

where prolonged high temperature exposure could possibly damage electrical performance.

Design Considerations

In addition to the problem of resin selection, there are ten basic factors which influence the design of epoxy cast parts. These factors, and their significance in the design of the five typical castings shown, are discussed below. Here the major design objectives were large size, close tolerances and minimum finish machining:

Mold materials. Steel molds are quite satisfactory for production casting. Steel is inexpensive, easy to work, hard enough to withstand clean-up and sufficiently porous to hold the mold release agent. Ground surfaces are satisfactory for mold cavities, but cores should be ground and polished to facilitate removal.

Draft requirements. Draft can often be eliminated, but this is best determined by test with several mold designs. The flow block, Fig. 2, for pH measurement electrodes, is cast in a mold with parallel sides. Cores are withdrawn and the sides removed one by one. The gas washer casting, Fig. 3, is in two parts; the lower section is 5 in. long and is readily removed from the mold with no taper. The gas sample conditioning units, Figs. 4 and 5, are in parallel-sided molds. The main body, Fig. 6, for an immersion-type pH measurement assembly, is

TABLE I—CHARACTERISTICS OF CASTING RESINS (Continued)

Characteristic	For All Casting Resins	For Epoxies
Hazards	Many resins have one or more volatile components which may be flammable, toxic or irritating to the skin. Catalysts, particularly the unstable peroxides, must be handled with care to avoid explosion. A good general rule is to handle components in a ventilated area, well away from open flames or sparks.	Components are safe. Epoxies are not explosive as are resins containing styrene monomer. Hardeners are safe. Unstable peroxide catalysts such as benzoyl peroxide, are not required. Amine hardeners can irritate skin and eyes, however. Normal cleanliness and ventilating hoods for mixing minimize this difficulty.
Machinability	Resin shrinkage during cure often prevents casting of such details as small holes, bosses, fine threads or smooth surfaces for marking. Because these details must be added by subsequent machining, resin brittleness must be considered to minimize chipping.	Good machinability. Rotational speed for drilling, facing and counterboring: about 500 rpm, with low feed. Drill-bit profile: included angle 60 to 140°, rake angle 0°, lip-clearance angle 12 to 20°. Chemical resistance of epoxies permits use of machining coolants where needed.
Chemical Resistance	No casting resin is immune to all chemical agents and corrosive conditions. Chemical resistance is relative, and depends upon a combination of factors: the nature, concentration and temperature of the chemical medium and the time of exposure. Resistance of casting resins to chemical action is generally good.	Good chemical resistance. Epoxies are superior to polyesters, though both are limited where organic solvents are involved. Phenolics are used with organic solvents, however are inferior to the epoxies in alkaline solutions. Silicones are better for both, though higher in cost.
Dielectric Properties	Casting resins are widely used to support and protect electrical components however, dielectric properties of various resins are sharply dependent upon frequency and temperature. For a survey on the role of casting resins in electronic applications, see 32-page Special Report in ELECTRONICS, October 1956.	High dielectric strength Epoxies average 400–500 volts/mil which, together with low shrinkage, makes them ideal for low frequency electrical embedments. Many epoxy potting formulations are in use in the electronics field.
Mold Release	Although casting resins shrink during cure, most of them also have adhesive qualities. Adhesion of resin to mold makes the casting difficult to remove and restrains shrinkage during cure, thus often contributing to crack formation. Mold release agents are therefore necessary. These agents, termed abrasives, vary from simple waxes to specially prepared silicones.	High adhesion. Epoxies are among the best adhesives available, and therefore require more careful mold preparation than other casting resins. With proper mold release, however, epoxy castings are no more difficult to remove than polyesters, phenolics, acrylics or styrenes. Silicone release agents are most commonly used. Molds may also be lined with PVC dispersions baked in place.
Transparency	Transparency of casting resins is generally good, and is improving. For optical applications, the resins are rank-ordered: acrylics, polyesters, epoxies, silicones and phenolics. A straw-colored transparent phenolic is available, but its chemical resistance is only fair.	Low transparency. Epoxies are amber in color, but are sufficiently transparent for most applications if walls are thin. Where optical clarity is essential, the polyesters, styrenes or acrylics are superior.
Cost	Two factors, in addition to production time, are initial cost of resin and catalyst, and amount of waste expected. Resins are available for less than $1 per lb; others, compounded for special purposes, cost as high as $15 per lb. Mixing larger quantities than are needed is the most common cause of material waste. With the small percentages of catalyst, accelerator, and dryer involved, careful selection of the appropriate weighing system will reduce waste by overmixing.	High cost. Epoxies are more expensive than other casting resins except for silicones. Average per-pound cost in 50-gallon-drum lots are: Epoxy, $1.25 Phenolic. $0.75 Polyester, $0.67; Silicone, $1.45.

cast in a tapered mold but the taper is a functional part of the design. Where taper is needed for removal, as the 3 in. long hose fitting in Fig. 6, 1½ to 2° is sufficient.

Cores. Solid steel coring is satisfactory for producing internal cavities. The pH immersion assembly, for example, consists of a cast base and dome cemented together with epoxy resin. The base mold contains three steel threaded cores which unscrew from the casting after cure. The dome has one solid core removed by arbor press using special tools. Mold parts are shown in Fig. 7. Note special Teflon cores.

Intersecting passages can be cast by appropriate core design. The three electrode cavities for the pH flow block of Fig. 2 are connected to a common header. By making the header cross-section half-round, the vertical core tie rods can be removed easily. Vertical cores containing electrode threads are then unscrewed.

Some passages are too small for satisfactory casting. In the gas sample regulator block, for example, passages vary from $\frac{5}{32}$ in. to ½ in. diameter and are machined. A large 1½ in. filter cavity in the top (unshown), and the three cavities with vial threads, are cast.

Internal cavities can also be made by the lost wax method, using the exothermic action to melt the wax core. This procedure is limited to the room tempera-

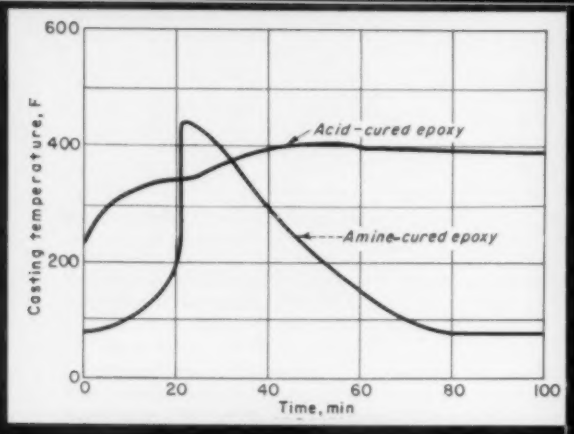


Fig. 1—Casting temperature during cure. Peaks in amine-cured epoxy can cause cracking in large castings. Acid-cured, with flat curve, is preferable.

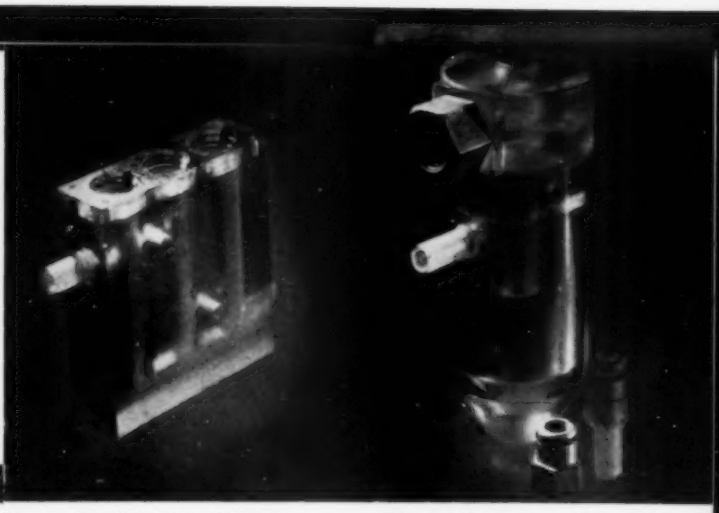


Fig. 2—Flow block for pH meter. Note as-cast female threads and half-round header for wells.

Fig. 3—Flue gas washing unit is made in two pieces cemented together. Height is 9 in.

ture curing resins; however, a resin must be selected which gels before the exothermic peak melts the core, otherwise the casting will collapse. Low melting point alloys such as rose metal and solder have been used; but only silicone resins will stand the melting temperatures involved. A further disadvantage of the lost core technique is that a new core must be made for each successive casting.

Threads. Male threads require split molds in most cases. Castings have been made with protruding male threads by having solid portions of the mold unscrew from the castings; however, cracking often occurs. In such cases, a separate fitting is machined, inserted and sealed with catalyzed monomer; note the hose fittings in the pH flow block. Female threads are made by coring and the peaks of these threads are broken to prevent cracking at the root of the image thread.

Connecting metal parts. Embedment of metal fittings is satisfactory provided temperature changes in service are moderate. Leakage between metal pipe and as-cast female threads is difficult to prevent because of differences in thermal expansion. However, metal adapters can be fastened to the epoxy casting in several ways: The ¾ in. steel side adapter on the gas washer is held in place with two countersunk screws, with an O-ring to insure against leakage. The small ¾ in. steel adapter fits to the top hole and is held in place with an O-ring snap-fit. The steel coupling on the pH immersion assembly is screwed to an interior nut which sits in a hexogonal recess (See Fig. 7) cast in the bell. Again, an O-ring is added for sealing. This assembly is made before the base is cemented in place.

Mold releases. Because of their good adhesive qualities, epoxies require a parting or release agent for the mold. Simple oils or waxes seldom suffice for these resins. The castings, described here are cast against a silicone release agent, either Dow-Corning R-671 or Houghton Laboratories Hysol 670. Application is by brush or spray-gun to a clean mold. After a room temperature drying period of about 2 hr, the coating is cured at 200 C for 8-10 hr. Other suitable parting agents are given in Table II. For precision parts, thickness of release agent is kept to a minimum.

Curing cycle. The low exothermic action of the acid hardened epoxies eliminates such measures as long cures, externally cooled molds and casting by layers. The larger parts illustrated are cast with Hysol 6000-PR resin and Hysol CA-1 hardener. Both resin and hardener are solid granules at room temperature and are heated to 140 C and 130 C respectively to liquify.

Table II—Mold Release Agents

Release	Approx. Cost	Manufacturer
D.C.R.-671	$11.00/gal.	Dow Corning Corporation
Teflon	(See note)	E. I. du Pont de Nemours
Hysol M670	$15.00/gal.	Houghton Laboratories, Inc.
Kel-F	(See note)	M. W. Kellogg Co.
Sonite	$7.00/gal.	Smooth-On Mfg. Co.

Note—semi-permanent liner, best applied by specialist

Table III
Cure Cycle for Epoxy Casting Shown in Fig. 3

Initial Mixing Temperature	140 C
Cure Temperature	180 C
Cure Time	2 hr
Annual Temperature	100 C
Anneal Time	24 hr
Cool Time	2 hr

Table IV
Manufacturers and Compounders of Epoxy Casting Resins

Trade Name	Manufacturer
Armstrong	Armstrong Products
Bakelite	Bakelite Corporation*
Helix	Carl H. Biggs Co.
Araldite	Ciba, Co., Inc.*
Stycast	Emerson & Cuming, Inc.
Hysol	Houghton Laboratories, Inc.
Marblette	Marblette Corp.
Scotchcast	Minnesota Mining & Mfg. Co.
Randac	Mitchell Rand Insulation Co.
Epon	Shell Chemical Corp.*

*Suppliers of basic resins only; others are compounders.

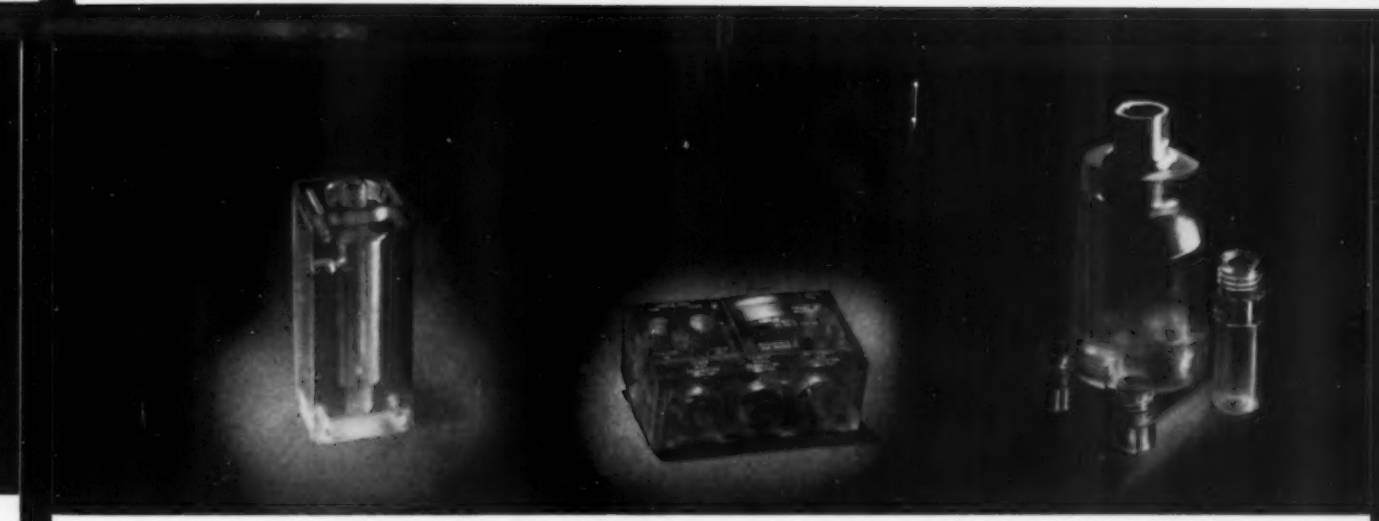


Fig. 4—Condensate gas separator is cored for 3 diameters. Top plug with hose fitting is cemented in place.

Fig. 5—Gas sample regulator block has cast female threads and one machined side for silk-screening labels.

Fig. 6—Immersion assembly for pH meter composed of base and dome cemented together. Fittings are cast in split molds.

After weighing, mixing and pouring, the casting is slowly brought to curing temperature, held there for a predetermined period, and cooled slowly.

It is hard to generalize on heating rate, curing time and temperature, and cooling rate. Curing temperatures vary from 60 C to 200 C; curing times from 1 to 20 hr. Heating and cooling rates depend upon the size of the casting; larger castings require slower rates. A cure cycle must be established for each part using a specific resin. Table III shows the cycle used for the gas washer casting in Fig. 3. Resin manufacturers can be of help in establishing correct procedures.

Finishes and marking. Except where a casting must be marked, mold finish is usually sufficient; however, the open face is machined to remove the meniscus and any surface bubbles remaining. Some revision of surface speeds and tool profiles are necessary with epoxies. All parts here except the gas sample regulating unit use as-cast surfaces. This part requires a smooth flat surface for lettering, which is applied by the silk screen process.

Cost. The advantage of casting cavities over machining them is illustrated by the pH flow block, Fig. 2. Initially, all surfaces were milled and all holes drilled. Cost of the block as-cast today is only 56% of the machined block.

EDITOR'S NOTE: Recent articles on design aspects of plastic parts include the following:

"Resins for Reinforced Plastics," May 1956 page 198. Five major classes of resins evaluated for processing characteristics, mechanical and electrical properties, appearance, cost, advantages and limitations.

"Tough, Rigid Thermoplastics," November 1956 page 167. Plastics for high-impact applications; physical, mechanical, electrical and optical properties for 28 compositions.

"New Materials by Irradiation," April 1957 page 167. A special report on how irradiation affects materials; mechanism of property change in plastics, graft copolymers by irradiation.

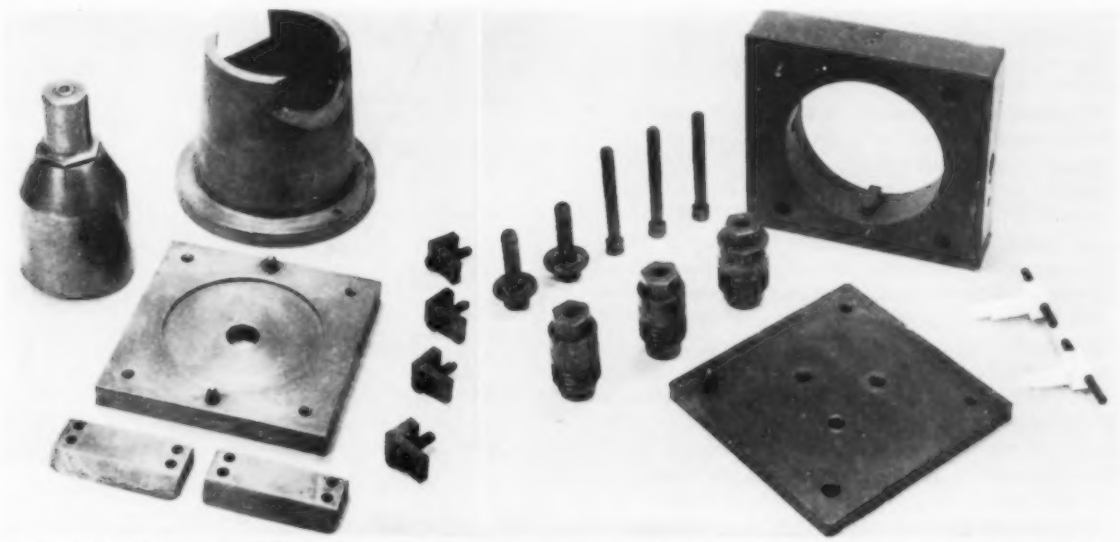
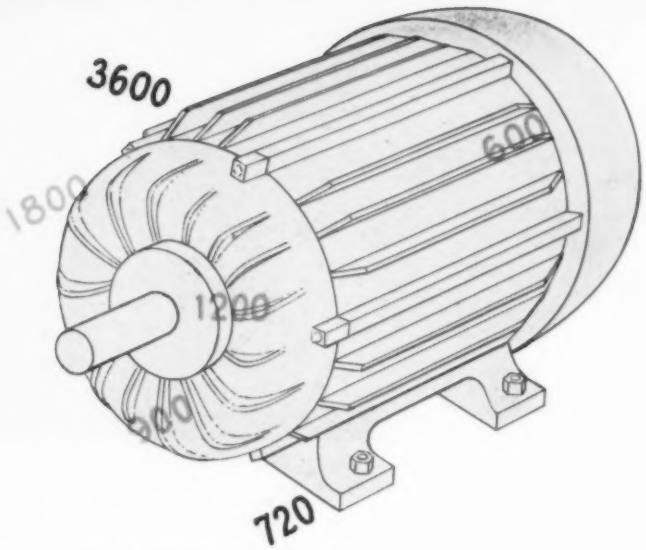


Fig. 7—Steel molds for dome (left) and base (right) of pH immersion assembly in Fig. 6. Note hex on dome core to provide fastener recess inside dome and Teflon cores for recesses in base. Three threaded holes are cast with steel cores mounted on base plate.

How to select motor type to match load characteristics for . . .



MULTISPEED MOTORS

Typical loads, starting torques and currents for 2, 3, or 4-speed constant-torque, variable-torque, and constant-hp motors; relative sizes and costs, and mechanical and electrical characteristics

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Application Engineer
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Multispeed squirrel-cage induction motors operate at any one of two, three, or four speeds which are selected by connecting a single stator winding, or two separate windings, to the line in the proper manner. The various standard speed connections for these motors were shown in a previous article, "Controls for Multispeed Motors," February 1957 page 183. These motors are available with running characteristics for three basic types of loads: constant torque, variable torque, and constant horsepower.

Constant-torque load characteristics are needed in motors used to drive such loads as conveyors, compressors, mixers, and printing presses. For example, a conveyor system under a constant load, Fig. 1, requires a constant torque because essentially the same torque is needed to operate the conveyor regardless of speed. However, horsepower varies inversely with speed because horsepower is the product of torque and speed.

This conveyor mentioned above can be driven at four speeds by applying a 1750/1150/870/570-rpm motor with hp ratings of 20/13.3/10/6.6. Although the motor is designed for constant-torque operation, at all full-load speeds, starting torques vary (Table I) because of required motor design compromises which must be made to produce best overall performance at all basic speeds.

Typical speed-torque curves of a 4-speed constant-torque motor rated 75/50/37.5/25 hp at 1750/1150/875/575 rpm are shown in Fig. 2. Speed-torque curves are shown at (A) for each speed connection; full-load torque is the same for all full-load speeds.

Variable-torque loads are typical of centrifugal pumps, fans, and blowers. An example of a centrifugal pump load is also shown in Fig. 1. For these pumps, the output is directly proportional to the drive speed; the total head of pressure against which the pump works is proportional to the square of the drive speed.

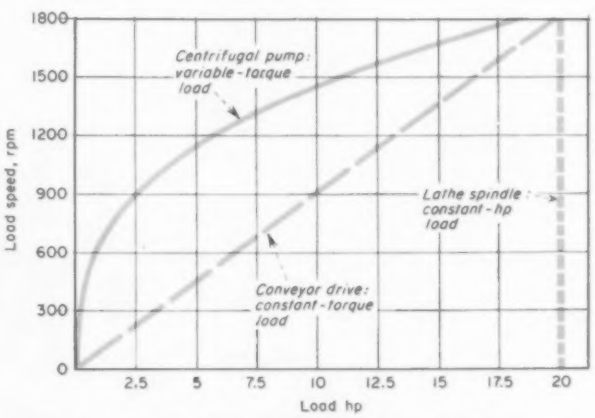


Fig. 1—Examples of three basic load characteristics: variable-torque, constant-torque, and constant-horsepower. Multispeed motors are chosen to approximate these characteristics at 2, 3, or 4 basic operating speeds.

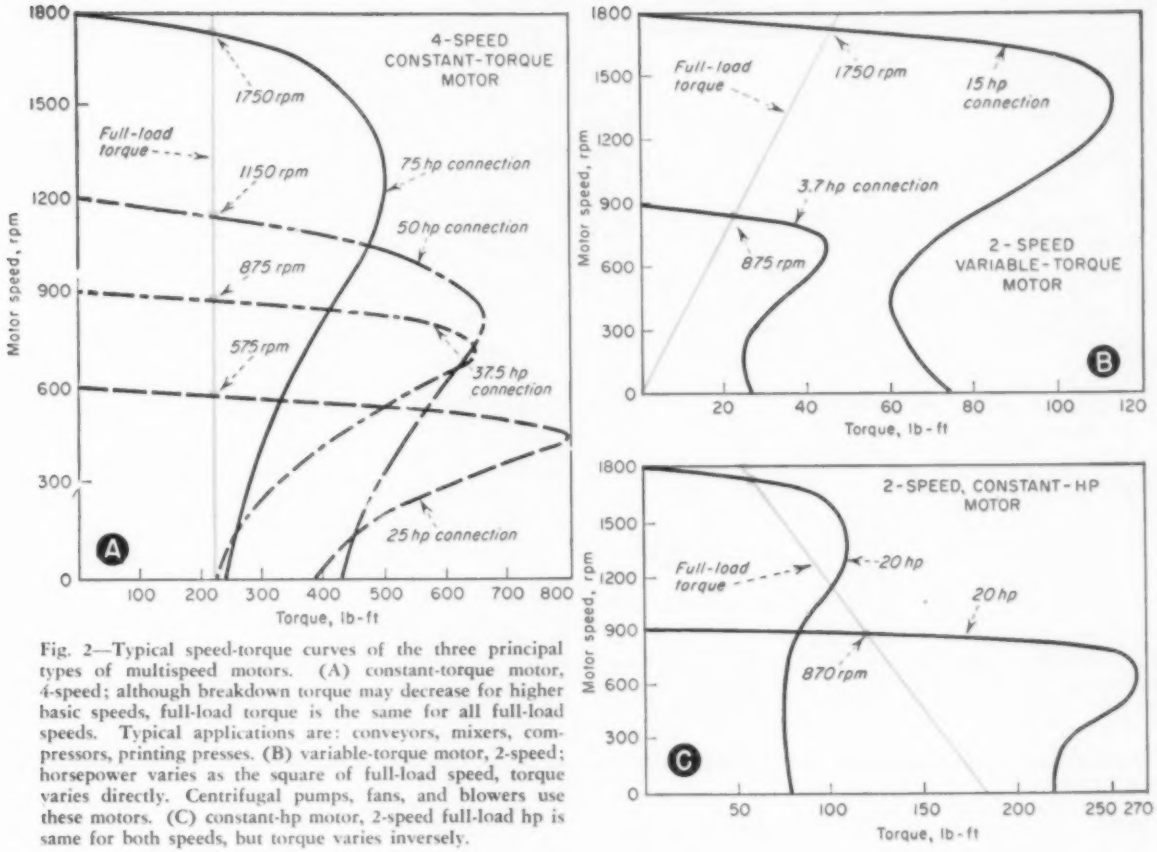


Fig. 2—Typical speed-torque curves of the three principal types of multispeed motors. (A) constant-torque motor, 4-speed; although breakdown torque may decrease for higher basic speeds, full-load torque is the same for all full-load speeds. Typical applications are: conveyors, mixers, compressors, printing presses. (B) variable-torque motor, 2-speed; horsepower varies as the square of full-load speed, torque varies directly. Centrifugal pumps, fans, and blowers use these motors. (C) constant-hp motor, 2-speed full-load hp is same for both speeds, but torque varies inversely.

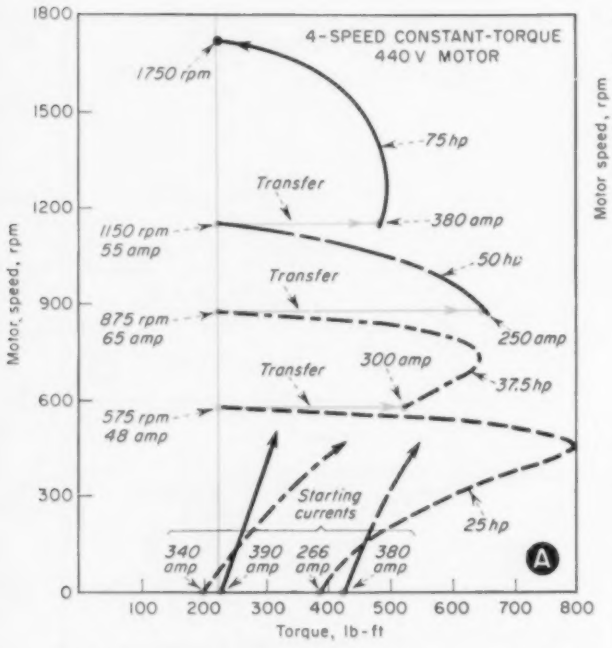
Drive horsepower, because it is proportional to the product of output and total head, is therefore proportional to the cube of the pump speed.

The unit given as an example pumps 4 gpm against a total head of 127 ft and requires 18.5 hp at 1800 rpm. The variable-torque motor for this drive would be a standard motor rated 20/8.9/5/2.2 hp at 1800/1200/900/600 rpm synchronous speeds. In the multispeed variable-torque motor, horsepower varies as the square of the speed; consequently, at lower pump speeds motor hp is higher than required.

Speed-torque characteristics of a 2-speed, variable-torque motor are given in Fig. 2(B). This type motor gives most efficient performance when the load horse-

Table I—Characteristics of Typical Multispeed Induction Motors

Type	Line Voltage	No. of Windings	No. of Speeds	Full-load Operation						Starting	
				Speeds	Hp	Efficiency, per cent	Power factor	Torque, lb-ft	Line Current, amp	Torque, lb-ft	Locked-rotor Current, amp.
Variable Torque	440 v	1	2	1750	25	88.5	90.5	75.5	30.6	113	225
				870	6.2	87.0	85.0	37.4	8.2	65	60
Constant Torque	440 v	2	4	1750	25	88.6	88.7	75	31.5	80	186
				1150	17	88.1	89.9	77.5	21.5	70	118
				870	12	84.5	53.4	72.5	27	121	154
				570	8.3	82.3	60.1	76.3	17	140	81
Constant Hp	440 v	2	4	1740	25	84.5	92.5	75.5	33	111	205
				1150	25	87.9	91.4	114	33	255	202
				870	25	88.6	71.5	151	39	270	255
				570	25	88.4	68.8	230	42	525	242



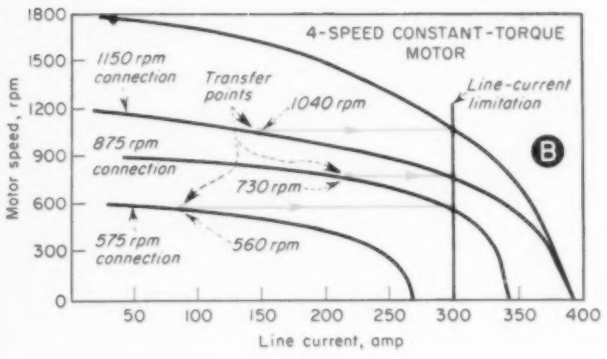


Fig. 3—Sequence starting of multispeed motors provides higher starting torques and minimizes line current. (A) Full-voltage sequence starting of 4-speed constant-torque motor rated 75/50/37.5/25 hp at 1750/1150/875/575 rpm; motor is started on the 25-hp 575-rpm connection, drawing only 266 amp. At 575 rpm it is transferred to the 37.5-hp 875-rpm connection, producing close to maximum torque. If started on the 50-hp connection, it produces slightly higher torque but draws 380 amp, or 43% greater current. Starting on the 50-hp or 75-hp connection produces substantially smaller torque with high initial current. Usual practice allows motor to reach full-load speed at each step before transfer.

(B) Transferring at other than full-load speeds when starting, depends on application. Here line-current limitation of 300 amp determines transfer point for 4-speed constant-torque motor. Transferring at higher speeds than those indicated increases starting time; transferring at lower, exceeds current limitation and is consequently not desirable.

power varies as the square of motor speed at each step.

Constant-horsepower loads require a drive hp which is directly proportional to the product of the speed and torque. Typical applications are lathes, drills, and milling machines. For example, a four-speed lathe (1750/1150/875/575 rpm) Fig. 1, normally takes a heavy, rough cut at lowest speed; for this cut, torque is high. Motor speeds are increased for lighter cuts, and torque decreases, ending with a finish cut at high speed. Because torque decreases as speed increases, the product of the two is approximately constant, thereby requiring a constant horsepower at various drive speeds. Speed-torque characteristics of a 2-speed, constant-hp motor are shown at (C) in Fig. 2.

Starting Current and Torque

Starting characteristics of multispeed motors are similar to those of single-speed units. Starting in-rush currents, Table I, are normally between 5½ to 7 times full-load currents. Starting torques may not be so high as for the equivalent single-speed rating.

Multispeed motors may use selective starting in which the operator can start at any base speed; they may use compelling starting, in which the operator must go through a predetermined sequence from low to highest speed, waiting at each transfer step; or they may use automatic-compelling starting in which case only the START button is pressed and the control circuits automatically perform proper sequencing in the proper time. A detailed discussion of the various starting systems and functions was presented in the earlier article, "Controls for Multispeed Motors," February 1957 page 183.

Where high starting torque is required, sequence starting can be used for constant-torque and constant-hp drives. In these cases the motor is started on the lowest speed where torque is usually highest; it is then switched successively to higher speeds.

Sequence starting tends to minimize starting currents while providing the higher torques for breakaway and acceleration. For example, sequence starting for the 4-speed constant-torque motor of Fig. 2(A) is shown in Fig. 3(A). Starting on the 575-rpm connection, this motor draws 266 amp and produces 390 lb-ft torque, and is then switched progressively to the highest speed. A start on the 1750-rmp connection draws close to 400 amp and produces only 242 lb-ft of torque.

Although usual practice allows the motor to reach full-load speed for each connection before transferring to the next higher one, this is not necessary. In some applications it may be possible to transfer at speeds other than full-load so long as line-current limitations are not exceeded, as shown in (B), which gives speed vs line current for a constant-torque 25/17/12/8.3-hp, 1750/1150/875/575-rpm motor. Line current is limited here to 300 amp at 440 v. Full-voltage starting is used and the connections are transferred at that speed at which line current of the next step is within the established limit. If required, reduced-voltage starting, described in "Starting Methods for Three-Phase Motors," February 1956 page 183, can be used.

Sequence starting is applicable to variable torque

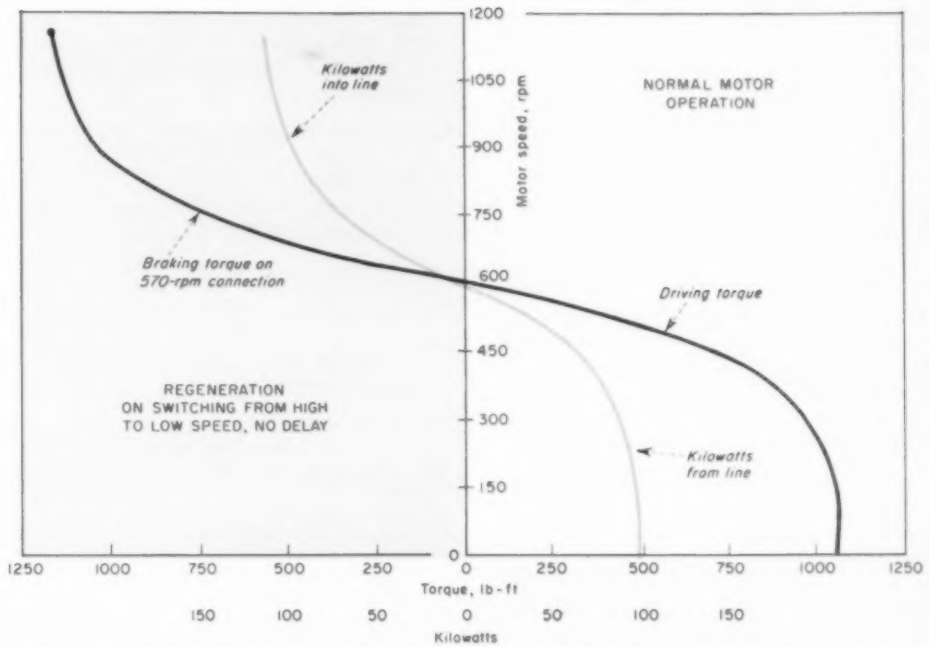


Fig. 4—Transferring line connections from a high to a lower speed without sufficient reduction in speed, plugs motor; it then becomes an induction generator, feeding energy back into line until speed is reduced to proper point. Here, a motor is instantly switched from a 1250 to a 575-rpm connection. Colored line shows power fed back into line.

and constant-hp drives. For the constant-hp motor, Fig. 2(C), high starting torque is obtained in this manner. For variable-torque drives, starting torque is lowest when using sequence starting. However, this type drive is normally started unloaded and starting torque is seldom critical.

Transfer from High to Low Speed

Switching from a high speed to a lower is accomplished with minimum line disturbance and shock to the machine by cutting off power and, usually automatically, allowing the motor to coast to the next lower speed before reenergizing the windings. Coasting time increases with increasing machine inertia and decreases with increasing friction and windage.

Reenergizing motor windings before speed is reduced to the desired value, causes the motor to become an induction generator, feeding current back into the line and plugging the rotor from the high to the lower speed. An example is given in Fig. 4, which shows the braking torque produced by a centrifuge motor switched from a 1250 to a 575-rpm connection without time

Table II — Approximate Relative Sizes and Costs of 25-hp, Open, Drip-proof Single-speed and Four-speed Motors

Motor Characteristics			NEMA	Frame Dimensions, in.		Cost,
Full-load Speed, rpm	No. of Speeds	Torque-Hp Characteristics	Frame No.	Length	Dia.	%
1750	1	.....	364	22	17	100
570	1	.....	445	30-½	25-⅞	225
1750 1150 870 570	4	Variable torque	404	24-⅛	19-¼	180
		Constant torque	444	28-½	25-⅞	235
		Constant hp	505	32	29-⅜	400

delay. The load is rapidly slowed because of the high braking torque. At 600-rpm (synchronous speed), the motor is neither drawing nor generating power. At lower speeds the unit operates as a motor, again driving the connected load. This method of switching can also be used for 3- and 4-speed motors.

Size and Cost

Size of a squirrel-cage induction motor increases both with hp rating and with decrease in rated speed. Cost of a motor increases with size. These factors are compared, in Table II, for 1750 and a 570-rpm single-speed 25-hp motors, together with comparable multispeed motors of variable-torque, constant-torque, and constant-hp characteristics.

Mechanical and Electrical Arrangements

Multispeed motors are available with most of the enclosures, mounting arrangements, and frame sizes of standard single-speed motors. Enclosures can be dripproof, splashproof, totally enclosed nonventilated, totally enclosed fan cooled, or explosion proof. Mountings can be flange or vertical, together with special shaft features, insulation, or bearing arrangements. Standard frames are used for motors up to NEMA size 505; above that the frames are usually nonstandard.

NEMA speed-torque characteristics, including Design B, high-torque Design C, or high-slip Design D, can be obtained in multispeed motors.

For usual duty cycles, application of these motors presents no problem. However, for severe duty cycles involving frequent starting, plugging and reversing, operation at each basic speed must be separately evaluated. This can be accomplished by considering each basic speed a separate problem and applying the standard methods for determining heat produced and motor temperature rise.

Wound-Rotor Motors

In addition to squirrel-cage motors, wound-rotor motors are also sometimes designed as two-speed units, requiring six slip rings. They usually have two speeds in the ratio of 2 to 1, such as 1800/900-rpm or 1200/600-rpm. The 1800/900-rpm motor can usually be adjusted from 1750 to approximately 900 rpm by inserting secondary resistance in the high-speed winding; the low speed connection provides an approximate range of 870 to 450 rpm.

EDITOR'S NOTE: In applying multispeed motors, factors such as speed, torque, temperature rise and duty cycle must be evaluated for each of the speeds at which the motor operates; relationship of these factors in selecting a drive motor has been discussed in several earlier issues.

"Controlling Temperature Rise in Squirrel Cage Induction Motors," January 1957 page 167, describes several methods for maintaining motor temperatures within safe operating limits. A new method for selecting the best combination of flywheel inertia and motor for cyclic power requirements of a high-inertia load, such as a punch press, is presented in "Driving High Inertia Loads," April 1956 page 142.

A detailed analysis of NEMA Design B, C and D torque and speed ratings appears in "The Importance of Duty Cycle in Selecting Polyphase Induction Motors," November 1954 page 174. A method of calculating various duty-cycle elements to satisfy drive requirements is included.

Starting and torque characteristics for different types of machine-tool loads is discussed in "Synchronous Motors Drives," in the Product Design Digest Issue, mid-October 1956 page H23. ●

Packaged D-c Power Sources for Machine Tools

REQUIREMENTS for d-c power continue to grow, and means for converting a-c to d-c are changing and improving. The semiconductor rectifier generally best meets modern usage. For medium d-c voltages selenium or the more recent silicon or germanium units are applied. Silicon is preferred because of its high inverse-voltage rating and ability to operate at higher ambient temperatures.

In selecting a d-c power supply for machine tools, some important factors to be considered are: application; original cost; installation cost; maintenance expense; and space and weight.

If the speed control required is for a constant-torque, variable-voltage motor, the motor-generator (m-g) set is still predominant above three hp. To obtain constant horsepower and speed by adjustment of the d-c motor shunt field, a selenium or silicon rectifier is usually specified.

Where overhauling loads occur, such as in elevator equipment or for high-inertia loads connected to a d-c motor, additional dynamic braking controls are required to absorb regenerated power.

Selenium rectifiers, in general, cost from 65 to 85 per cent of corresponding m-g sets. Silicon rectifiers currently cost more than selenium; but this cost is certain to come down.

The packaged rectifier is the least expensive to install, requiring only connection of a-c leads to the rectifier and the two d-c leads to the load. Taps are available for setting the d-c output to the desired value. On standard units, the limit of a-c voltage setting is plus or minus 10% of rated supply voltage.

Motor-generator sets require more maintenance than static rectifiers. For a 50-kw rectifier, space is about one-third and weight is less than 60% of the comparable m-g set.

Abstracted from: "Evaluating Packaged D-c Power Sources for Machine Tools" by E. J. Laughlin, Westinghouse Electric Corp., Buffalo, presented at the 21st Annual Machine Tool Electrification Forum; Buffalo, N. Y., April 24 and 25, 1957.

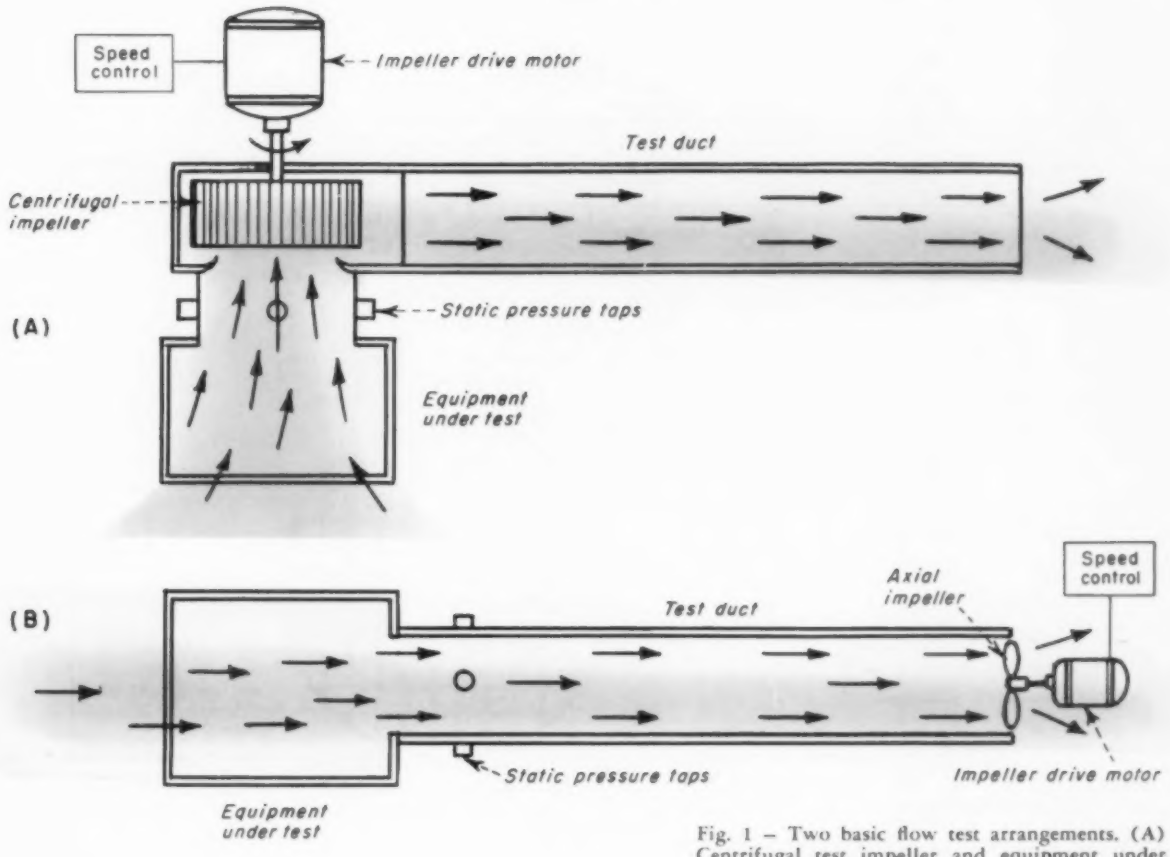


Fig. 1 – Two basic flow test arrangements. (A) Centrifugal test impeller and equipment under test on the upstream end of a test duct. (B) Axial test impeller and equipment under test on opposite ends of a test duct.

HOW YOU CAN MEASURE AIR FLOW

Rate and pressure can be determined by these practical test setups. Equipment may be made up of stock elements.

ERICH J. O. BRANDT

Development Engineer
The Torrington Manufacturing Co.

WHEN air is employed as the cooling medium, selection of the type of impeller and drive motor used to move the air past or through the equipment depends on the air flow rate and fan pressure needed. While costly and complex test methods are usually necessary for precise measurements of these quantities, simplified methods can give accuracies of 5% or better over a wide range of flow rate.

Basic Test Arrangement

The test setup must include means for producing a flow of air, varying the rate of flow and measuring flow rate and static pressure. These functions are accomplished in either of the test arrangements in Fig. 1. In (A), a centrifugal impeller located between the equipment under test and the upstream end of the test duct draws air through the equipment. The equipment

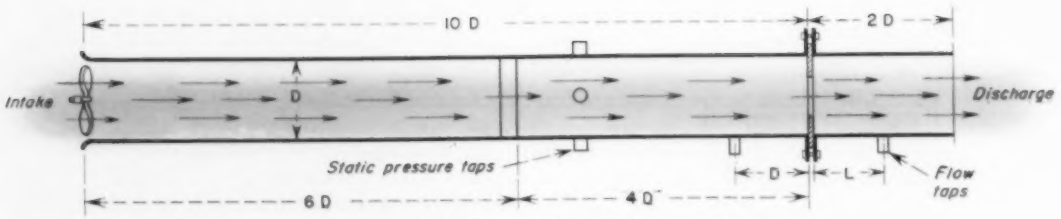


Fig. 3—Locations of sharp-edge orifice and flow taps in a test duct.

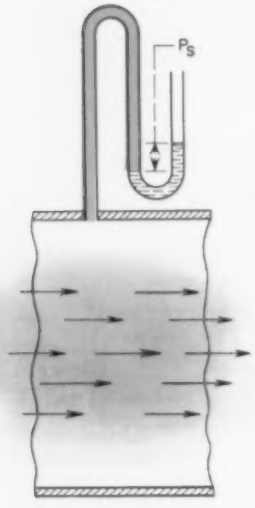


Fig. 2 — Schematic drawing of simple manometer indicating static pressure P_s in a test duct.

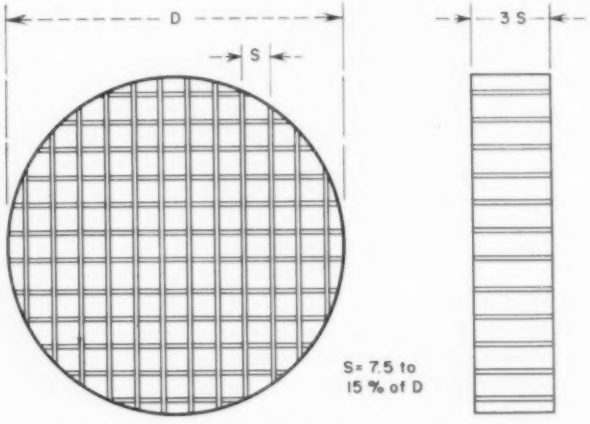


Fig. 4—Front and side view of recommended straightener, with opening size and length related to duct diameter.

under test may also be placed on the downstream end of the test duct. In (B) an axial impeller on the downstream end of a test duct draws air through the equipment under test and into the duct. Direction of air flow may be reversed without affecting test conditions.

In either case the size of the impeller is not critical, as long as it is large enough to provide a sufficiently wide range of flow rate. The centrifugal impeller test system may be slightly more expensive for the same testing capacity because of the added cost of the impeller housing; with round test ducts, a sheet-metal transformation piece is needed to minimize pressure loss as the air leaves the rectangular outlet opening in the housing. However, the spiral air flow produced by axial impellers is avoided.

Rate of air flow is conveniently varied for both impeller types either by changing the speed of the impeller drive motor or by using damper control. The size of the test impeller need never be changed as long as it is large enough. To determine the air flow required in actual operation, the impeller speed is varied until the desired rate of heat transfer is obtained in the equipment under test.

Flow rate (cfm) and static pressure (in inches of water) are measured in the test duct. Flow rate is constant at any point in the closed test system, and change in static pressure is negligible along a test duct with a smooth surface and constant size. However, the accuracy of flow and pressure readings is dependent on the uniformity of air flow over the duct cross section. This requires a minimum length for the test duct and proper location of the points of flow measurement.

Speed of the test impeller during flow measurements is not important. Performance data published by impeller manufacturers will aid in selecting an impeller that will provide the required flow and pressure at the desired speed and also fit into the space available in the test equipment.

STATIC PRESSURE

Static pressure (P_s) is indicated directly in inches of water (difference in water levels) on a manometer as shown in Fig. 2. Simplest form of manometer consists of a U-shaped glass tube with an inside diameter of 1/8 in. The tube is mounted on a section of plywood underlaid with graph paper scaled in inches. Water level in the tube (possibly colored for better readability) then indicates static pressure directly as the difference between static pressure in the duct (not including flow or velocity pressure) and atmospheric pressure. To obtain more accurate readings, particularly below 0.25 in. of water, the pressure gage may be inclined to expand the difference in water level. The gage may be located remotely with flexible connections (such as 3/16 in. rubber tubing) leading to the pressure tap in the duct. It is recommended that a commercial inclined pressure gage be purchased rather than attempting to make one within the engineering department.

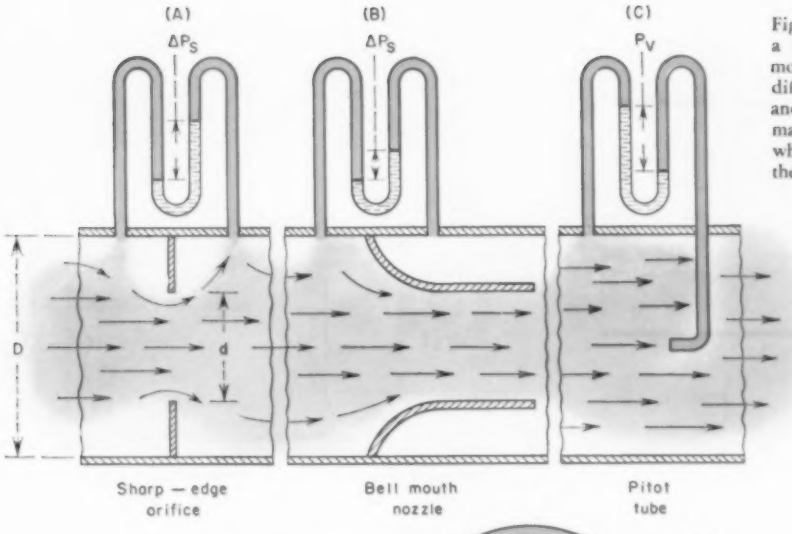


Fig. 6—(A) Schematic drawing of a sharp-edge orfice. (B) A bell-mouth nozzle, in which the pressure difference, ΔP_s between upstream and stream sides are indicated on a manometer. (C) A pitot tube in which the velocity pressure (P_v) is the difference in water level.

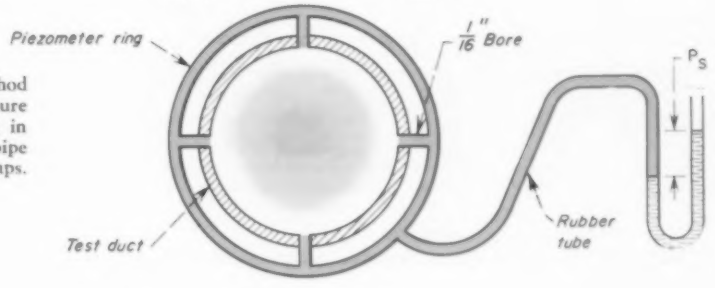


Fig. 5 — Recommended method for measuring static pressure provides an average reading in a manometer from a ring pipe connected to four pressure taps.

Location of Static Pressure Taps

Static pressure taps should be located on the intake side of the impeller near the equipment under test to measure the true static pressure drop. When locating the static pressure taps on the discharge side of an axial test impeller (as in Fig. 3), there should be a straightener and some length of duct between the point of pressure measurement and the impeller discharge to remove spiral flow. A straightener is not necessary between the static pressure taps and the discharge side of a centrifugal test impeller because spiral flow is negligible, though the taps should not be located too close to the discharge.

The straightener in Fig. 4 is a common type and can be easily fabricated from sheet metal. The indicated relative dimensions of the straightener openings and width with respect to duct diameter have been found most effective. The straightener should be located a distance of at least six duct diameters from the upstream end of the test duct.

Averaging Four Readings

Even with a straightener, the variation in static pressure indicated at different points around the circumference of the test duct can be quite large. It is good practice to obtain an average value of static pressure with a device such as shown in Fig. 5. Four pressure taps drilled in the duct wall are uniformly distributed around the circumference (bore diameter of 1/16 in. is common). The taps are then connected to a piezometer ring (usually copper) and a rubber tube extends from the pipe to the manometer. To minimize burrs on the inside of the pressure tap, holes should be drilled at high speeds with light pressure.

AIR FLOW RATE

Air flow rate may be determined in a test duct either by measuring the static-pressure drop across an obstruction or with a pitot tube.

The obstruction used in measuring flow may be either a sharp-edge orifice or a bell-mouth nozzle. In Fig 6(A), a sharp-edge orifice (of negligible thickness) of diameter d is located in the duct between two pressure (or flow) taps. The difference in the water levels in the manometer then represents the difference in static pressure (ΔP_s) between the upstream and downstream sides of the orifice. Similarly, in Fig 2(B), the manometer indicates the pressure difference on either side of the bell-mouth nozzle (for both obstructions, the diameter ratio d/D is the same). Formulas have been developed to give air flow as a function of the static-pressure difference.

The pitot tube, Fig. 6(C), indicates velocity pressure P_v as the difference in total pressure at the tube in the center of the duct and static pressure at the tap on the duct surface. Air flow rate is then proportional to the product of velocity pressure and duct cross section.

Both the sharp-edge orifice and bell-mouth nozzle

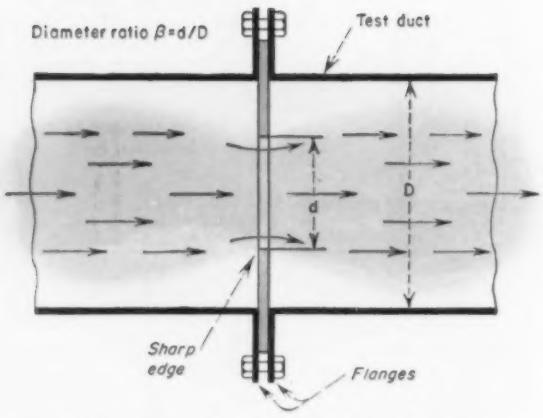
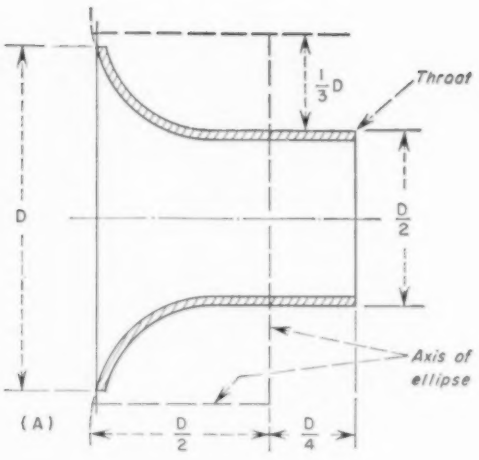


Fig. 7—Detailed cross section of a sharp-edge orifice between flanges in the test duct.



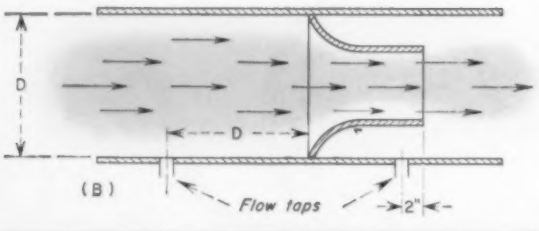


Fig. 8—(A) Detailed cross section of bell-mouth nozzle, as specified in NEMA Standards Publication FM 1-1955 (November, 1955). (B) Location of pressure taps when using a bell-mouth nozzle in the test duct.

can produce accurate readings in very little time (the pressure difference in the manometer can be used immediately). However, both devices must be treated carefully. Any damage to the sharp edge of the orifice or to the polished inner surface of the nozzle can cause a change in the orifice or nozzle discharge coefficient and, if not repaired or recalibrated, produce erroneous readings. The initial cost of a pitot-tube test setup is smaller than an orifice or nozzle, although the need for traversing the duct area to average readings means that the time involved in testing is longer. A pitot tube may be used to measure flow in either round or rectangular ducts. Orifices or nozzles should usually be used only in round ducts because the flow coefficients of these obstructions in rectangular ducts with different aspect ratios have not been well established.

Sharp-Edge Orifice

The sharp-edge orifice is simply a thin steel plate with a circular opening concentric with the duct axis (detailed in Fig. 7) and is therefore inexpensive. The throttle opening may be cut on a lathe from plate 1/16 in. thick (for ducts up to 6 in. dia) to 3/16 in. thick; any thickness in this range is satisfactory for use in test ducts from 6 to 48 in. in diameter. The edge of the orifice on the upstream side should be sharp and free of burrs.

The orifice is clamped between flanges in the duct, with gaskets cut to size so that they do not extend into the duct on the surface of the orifice (the inner diameter of the gasket should be at least 0.25 in. larger than the diameter of the test duct).

Accuracy of the pressure difference measured across the sharp-edge orifice depends on the uniformity of the air flow across the duct cross section. While the accuracy of orifice measurements improves as the length of test duct between the orifice and impeller output increases, the test arrangement and dimensions in Fig. 3 are capable of producing an accuracy of plus or minus 5% for values of diameter ratio β below 0.7. The distance L for the position of the downstream flow tap is given by

$$L = 0.9D\,[1 - \beta^2] \text{ in. and } \beta = d/D \qquad (1)$$

where all dimensions are given in inches.

The air flow rate in a sharp-edge orifice may be computed in the expression

$$Q = 4005KA\ \sqrt{\Delta P_s R} \quad \text{cfm} \qquad (2)$$

where A = area of throttle opening in square feet, R = ratio of standard to actual air density, and ΔP_s = indicated static pressure difference across the orifice in inches of water. The factor K, called the velocity of approach factor, may be determined in the formula

$$K = \frac{C}{\sqrt{1 - \beta^4}} \qquad (3)$$

in which C is the discharge coefficient of the sharp-edge orifice. The coefficient C may be assumed constant at 0.61 for orifices with diameter ratios β from 0.2 to 0.7, as long as the Reynolds Number is above 100,000. The Reynolds Number is a dimensionless factor representing the nature of air flow in the orifice and is given by

$$R_d = \frac{1550\,Q}{d} \qquad (4)$$

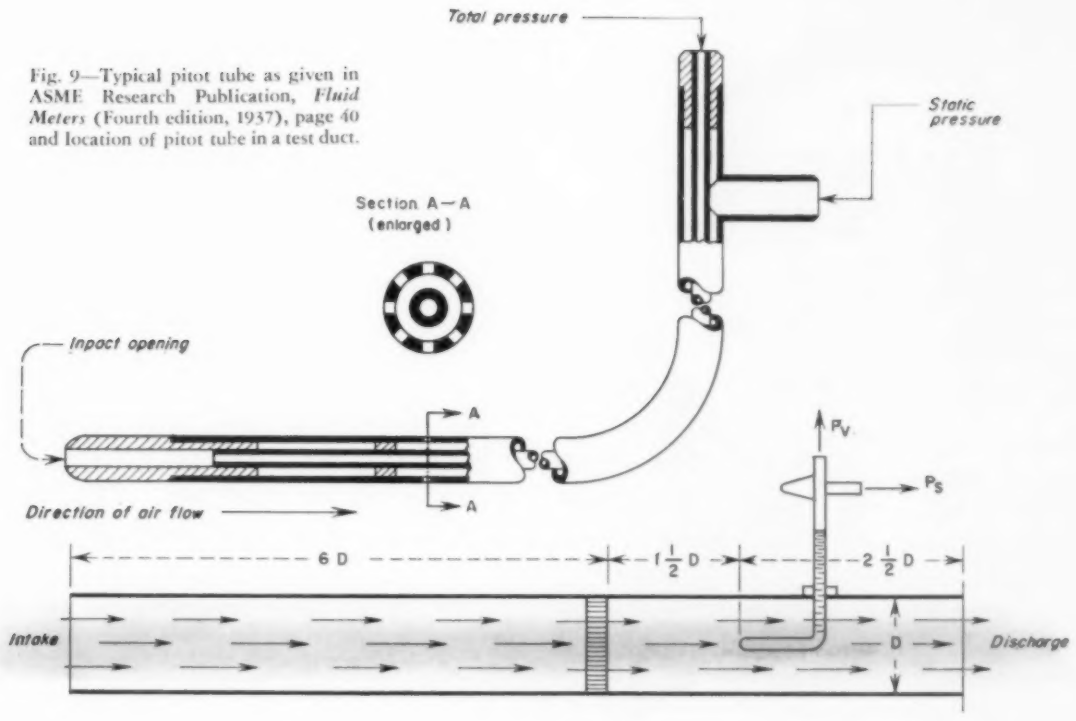


Fig. 9—Typical pitot tube as given in ASME Research Publication, *Fluid Meters* (Fourth edition, 1937), page 40 and location of pitot tube in a test duct.

where Q is in cfm and d in inches. The value of R_d can be determined from the test value of Q computed in Eq (2) for the orifice of diameter d. If R_d is found to be below 100,000 the orifice diameter should be reduced below $Q/64.6$ in. (corresponding to $R_d = 100{,}000$) to obtain a reasonably accurate flow rate.

Bell-Mouth Nozzle

Detailed construction of a standard nozzle (as defined in NEMA Standards Publication FM1-1955, *Electric Fans*) is given in Fig. 8(A) in terms of the major diameter D. Like the sharp-edge orifice, the bell-mouth nozzle is clamped between flanges in the test duct.

Flow taps are located in the duct surface on either side of the nozzle as shown in Fig. 8(B). Note that the downstream flow tap is located 2 in. on the upstream side of the discharge edge of the nozzle. The location of the nozzle, static-pressure taps and straightener in the test duct is the same as given for the sharp-edge orifice in Fig. 3.

Air flow rate in a bell-mouth nozzle is calculated in Eqs (2) and (3) as described above for a sharp-edge orifice, except that C is assumed constant at 0.99. Again, the Reynolds Number should be above 100,000.

Pitot Tube

A typical pitot tube as given in the ASME Research Publication, Fluid Meters is shown in Fig. 9. Location of the pitot tube and straightener in a test duct—with a length at least 10 times its diameter—is also indicated. Since there is no orifice or nozzle obstruction to add a pressure drop, the static-pressure taps may be located anywhere on the downstream side of the straightener.

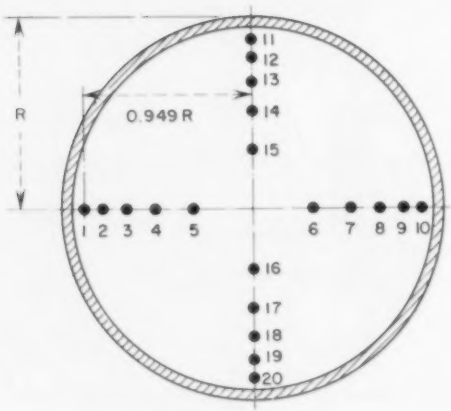
Orientation of the impact opening of pitot tube in duct may be indicated simply by mounting a metal vane (Fig. 9) on the tube parallel to the impact opening direction. The vertical position of the pitot tube may be calibrated on its stem above the packing gland. A number of readings must be taken in a traverse at various locations of the impact opening in the duct area to obtain an average flow velocity. Following are recommendations for traverse positions in measuring air velocity in round and rectangular ducts.

Traverse in a Round Duct

Location of the 20 points at which velocity is measured in a round test duct (no point at the center) are shown in Fig. 10. Four points are located on horizontal and vertical diameters in each of five concentric rings of equal area. Two traverses are then necessary to determine velocity at points 1-10 in one direction and then at points 11-20 in the perpendicular direction. The pressure readings at each of these points are converted into velocities and the velocities averaged. Air flow rate at standard density is then given by

$$V = 4005 \sqrt{P_v R}$$
$$Q = V_{avg} A_d \text{ cfm} \qquad (5)$$

where P_v = velocity pressure in inches of water and V = air velocity in feet per second at a given position of the pitot tube; A_d = cross-section area of duct in square feet, R = ratio of standard to actual air density.



Distance of pitot tube locations in the traverse

Center — 1 = 0.949 R
" — 2 = 0.837 R
" — 3 = 0.707 R
" — 4 = 0.548 R
" — 5 = 0.316 R

Fig. 10—Location of traverse points for a pitot tube in a round duct.

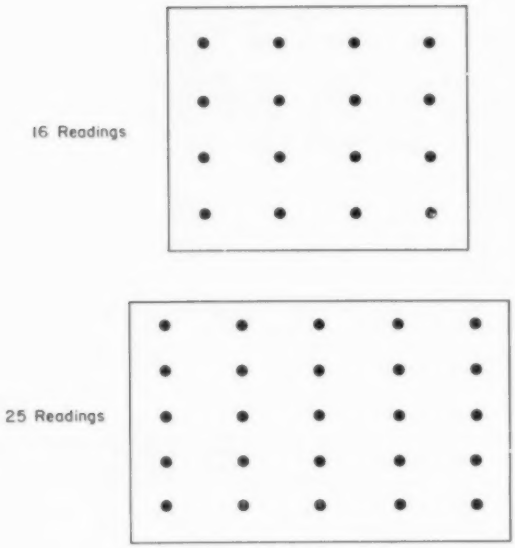


Fig. 11—Location of either 16 or 25 traverse points for a pitot tube in a rectangular duct.

Traverse in a Rectangular Duct

In traversing a rectangular duct to make velocity-pressure readings with a pitot tube, the cross section of the duct is divided into 16 (at least) or 25 (sufficient for most purposes) equal areas and velocity pressure is measured with the impact opening of each tube at the center of each area (Fig. 11). The smaller each area the more accurate will be the result. The use of 16 and 25 readings requires, respectively four and five pressure taps on one side of the duct for the pitot tube.

Conversion to Standard Conditions

Ratio R in Eqs (2), (3) and (4) converts actual ambient conditions to the standard air density of 0.075 lb/cu ft (air at 50% humidity, temperature 68 F and barometric pressure 29.92 in. of Hg) used in performance data published by impeller manufacturers. Dry and wet bulb thermometers and a barometer are then necessary for measuring ambient conditions during the test. A standard reference will then give the actual density for the measured temperatures and pressure so that R can be determined.

Example

Determine Q and P_s for a quantity of air flow that provides a necessary cooling effect on a high-power light source. The design permits a maximum diameter of 8 in. for a propeller fan in the space available, and the impeller motor speed will be 3450 rpm. A test arrangement is constructed as shown in Fig. 1(B) with a round test duct 10 in. in diameter and 8 ft long. Pressure and flow taps and a bell-mouth nozzle with a 6-in. throat diameter are located in the test duct as in Figs. 3 and 8(B).

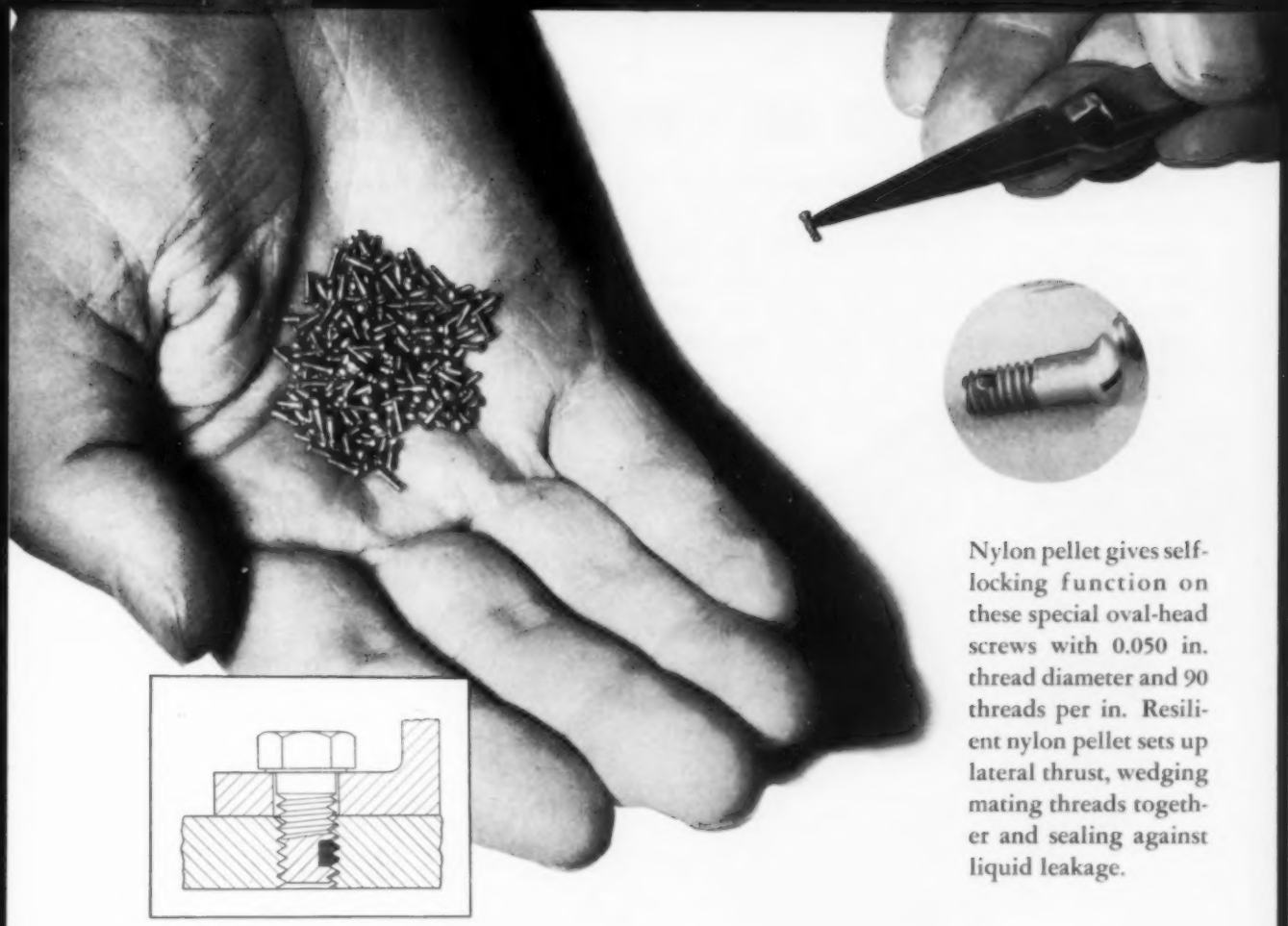
At the speed of the centrifugal test impeller that resulted in the desired air flow, the pressure difference ΔP, across the nozzle was 0.4 in. of water and the manometer indicated a static pressure of 0.65 in. of water. The barometer read 29.93 in. of Hg; the dry and wet-bulb thermometer readings were 78 F and 60 F, respectively.

Published density tables give actual air density as 0.0717 lb/cu ft and the ratio R is found to be 1.044. For $\beta = 0.6$ and $C = 0.99$, the factor K calculated in Eq (3) is 1.06. Using Eq (2) with a throttle area $A = 0.197$ sq ft, the flow rate at standard air density is calculated to be $Q = 542$ cfm. The static pressure reading is converted to standard conditions, $P_s = 0.65 \times 1.044 = 0.678$ in. of water.

Knowing the values of Q and P_s at standard conditions, a particular 8-in. propeller fan may be selected that will cool the light source properly when operating at 3450 rpm.

There may be instances in which high accuracy is not required and the ratio R may be assumed equal to one. In the above example the error is -2.2% in Q and -4.1% in P_s with $R = 1$. The error is usually within 3% in Q and 6% in P_s when the measurements are taken at sea level and room temperature but becomes greater at higher elevations. Because R is so easily determined it is recommended that it always be calculated.

EDITOR'S NOTE: **Recommendations and diagrams are drawn from NEMA Standards Publication FM 1-1955, *Electric Fans*, and A.S.M.E. Research Publications, *Fluid Meters, Their Theory and Application*, (Fourth Edition, 1937) and *Fluid Meters, Their Selection and Installation*, (1933). For a discussion of the effect of air temperature and density on heat transfer see "Fan Cooling—Influence of Altitude," June 1956 page 198.**



Nylon pellet gives self-locking function on these special oval-head screws with 0.050 in. thread diameter and 90 threads per in. Resilient nylon pellet sets up lateral thrust, wedging mating threads together and sealing against liquid leakage.

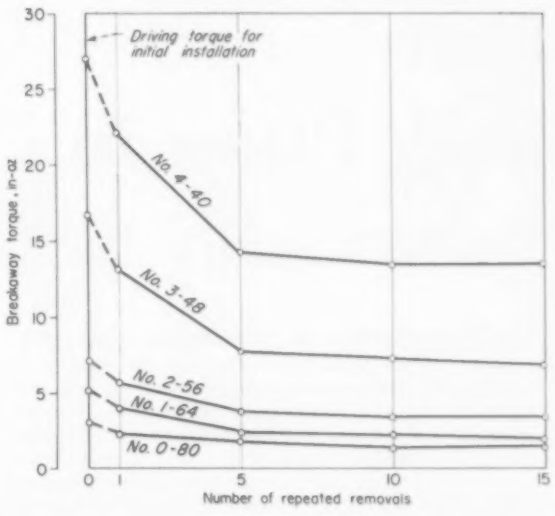
MINIATURE *Self-Locking* SCREWS

J. E. JOHNSON *Vice President, Engineering, Nylok Corporation*

SELF-LOCKING machine screws, using a nylon pellet for the locking medium, are now available in miniature sizes from #4-40 down to #0.-80 (0.060 in. screw dia), and have been manufactured in regular production runs in diameters as small as 0.050 in. (above), with 90 threads per in. With these screws, threaded conections on instruments, small electronic components, flight control equipment and optical products stay tight under shock and vibration.

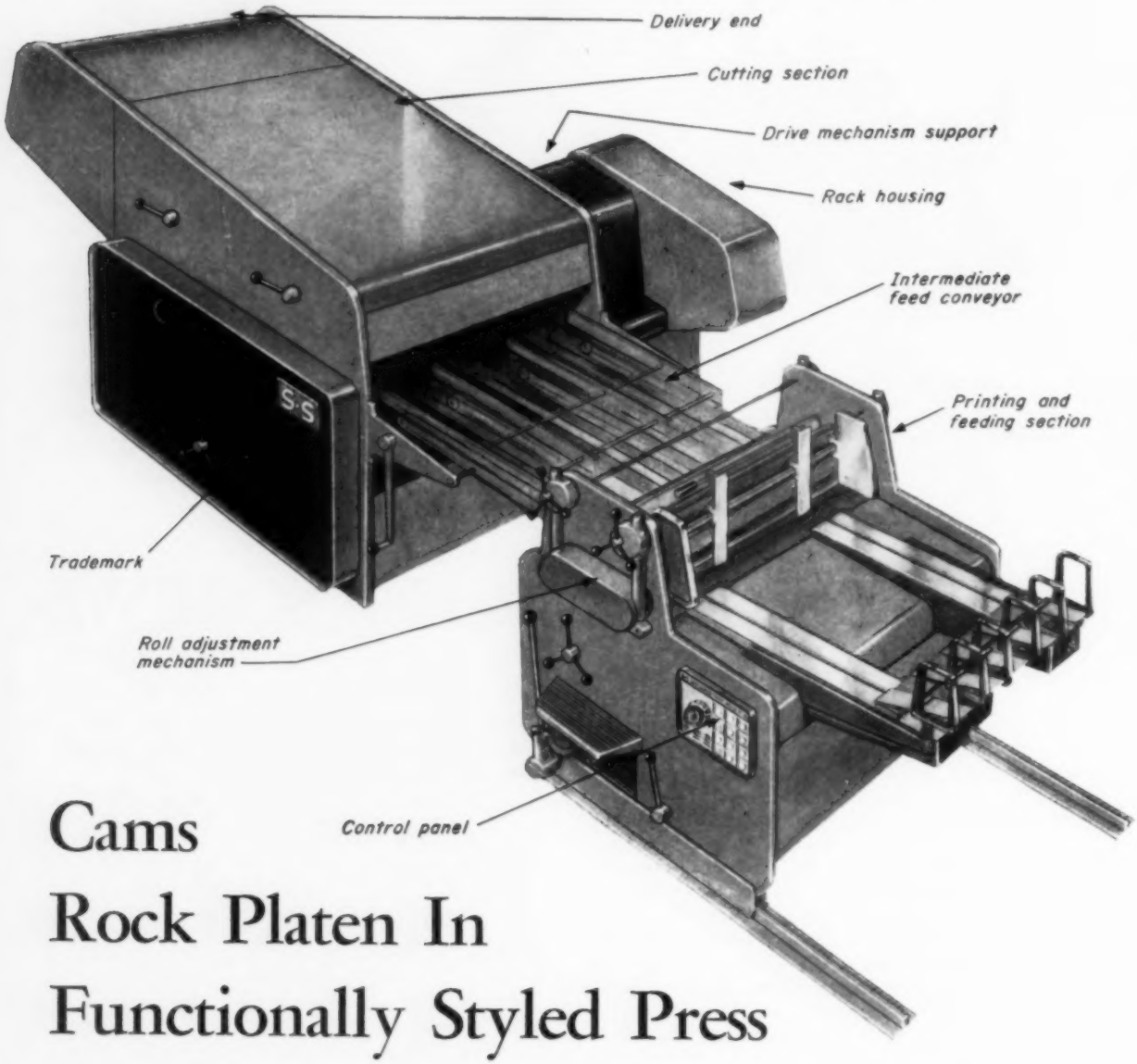
Since the screws can be reused repeatedly with little loss in self-locking ability, (see chart) they offer an alternative to expendable riveted construction for assemblies subjected to vibration. The fasteners can also act as self-locking adjustment screws since the nylon insert retains the screw in a fixed position without other locking means.

The nylon pellet is effective in stopping liquid leakage—the pellet acting as a dam against liquid flow along the thread helix. No leakage takes place, for example, when ½ in. bolts are subjected to 5000 psi oil pressures for 48 hr at temperatures up to 300 F. The nylon pellets are unaffected by oil when subjected to 120 day immersion at 160 F in a variety of liquids meeting the MIL-O-5606 and MIL-F-7083 specifications. Tests to determine maximum ranges of temperature and pressure are in process and will be reported shortly.



DESIGN FEATURES

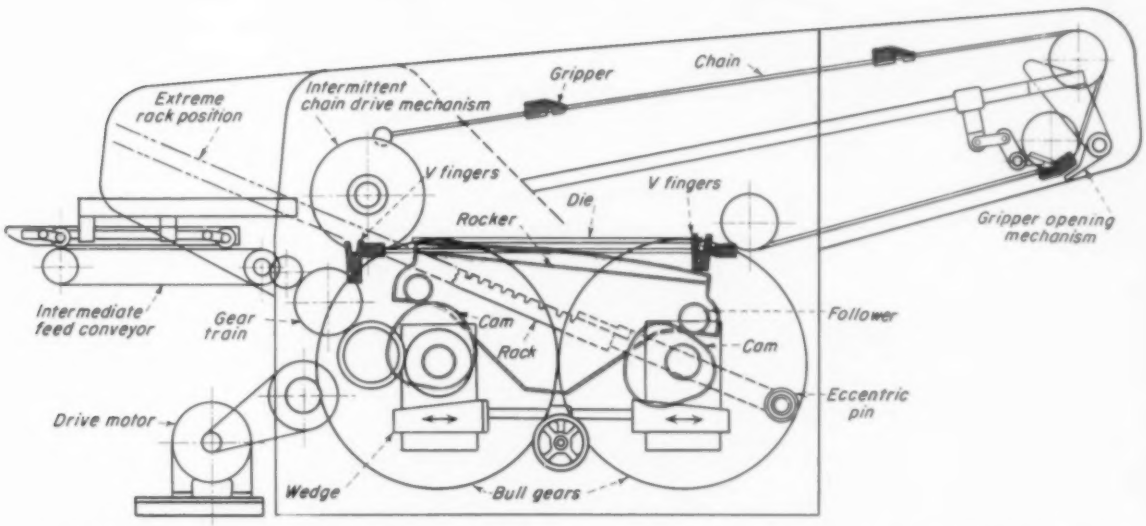
In this cutting and creasing press for corrugated sheets, synchronized cams raise the cutting platen, roll it against the die, then lower it to admit the next sheet. Made by the S & S Corrugated Paper Machinery Co., Inc., Brooklyn, N. Y., the machine will diecut, slot, and crease all types of corrugated and solid fibre board at speeds up to 60 impressions per minute. Feeding section includes a certificate printing attachment. Industrial designers, Raymond Loewy Associates, of New York City, worked with the S & S engineers to evolve a functional machine styling which utilizes low silhouette made possible by the rocking cutter drive.



Cams Rock Platen In Functionally Styled Press

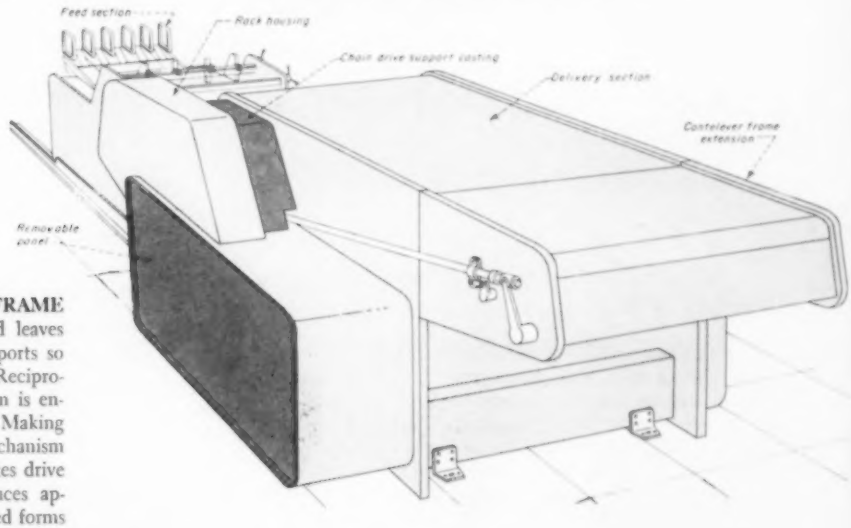
BASIC OBJECTIVE OF INDUSTRIAL DESIGNERS was to unify machine's appearance with functional forms, based on rectangles, which emphasize the low silhouette and present a machine-like appearance. Basic machine elements were treated individually as simple forms, then integrated into the overall appearance. Frame was changed from a casting to 2¼ in. thick steel side plates braced with structural crossbeams. New frame design not only costs less to make, but has greater rigidity and establishes functional lines around which machine is styled. Cutting and printing sections have separate frames to break up massive appearance and to allow printing section to move back to make rolls accessible during set up. Controls are centralized at a station most frequented by operator and combined with the nameplate as a secondary point of identification. Primary identification is nameplate on delivery section of machine.

IN NEW PRODUCTS



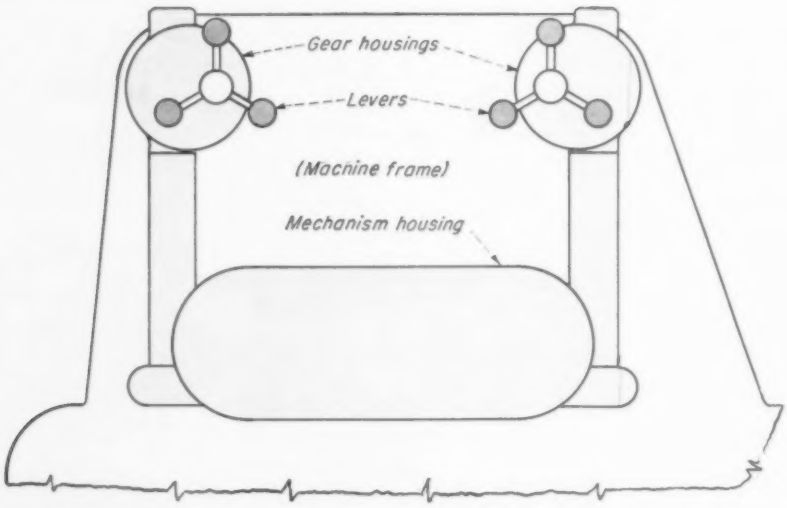
OSCILLATING MOTION OF ROCKER rolls lower platen against die to shear, rather than punch, odd shapes for special cartons. Shearing action is equivalent to motion of rotary die of 200 in. radius. As die contacts a small section of corrugated board at one time, cutting forces are small, and action is fast because moving masses have a short stroke. Using rotary drive with moving elements of cutting mechanism beneath die makes possible a more rigid frame and a lower machine. Bull gears which synchronize cams are driven by a 15-hp electric motor. An eccentric pin on one gear reciprocates a rack to drive intermittent chain drive mechanism which positions sheets for cutting. Power is taken off other camshaft to drive feeding and printing section, and intermediate feed conveyor.

Cutting pressure is adjusted with a turnbuckle device which positions wedges to raise or lower camshafts. Rocking platen is made of two sections. Lower section is a Meehanite casting. Upper section is a steel plate with a hardened steel jacket. Die chase slides out on a track which tilts to simplify adjustment. Corrugated sheets enter intermediate feed conveyor from feed and printing section (not shown) which houses a certificate stamp printer. Sheet is registered against stops and detectors, then held by grippers positioned by an intermittent-motion chain drive. To obtain accurate register in the pick-up and cutting positions, chain drive is first indexed by a stop pin, then pins on grippers are indexed by V fingers at each station. This procedure prevents wear in chain links from affecting register.

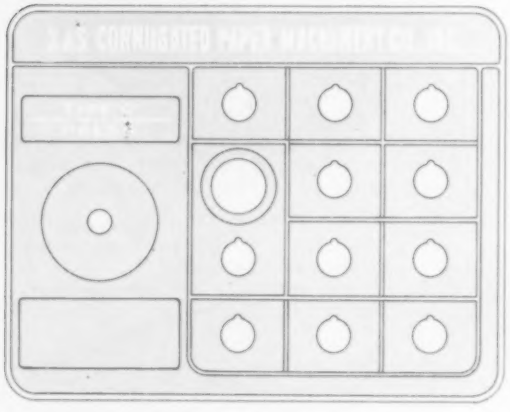


CANTILEVER EXTENSION OF FRAME houses discharge end of chain drive and leaves area beneath discharge point free of supports so sheets can drop directly on conveyors. Reciprocating rack which drives chain mechanism is enclosed in a housing at rear of machine. Making casting which supports chain drive mechanism lower than adjacent frame visually separates drive housing from delivery section and reduces apparent size of machine. To separate related forms in housing structure, panel configuration is made identical on both sides. These panels are removable plates, held in a frame fastened to the machine, which can be lifted out easily by two men for access to cam drives. Prototype machine used one housing for both chain drive mechanism and reciprocating rack, which presented a more massive and unrelated appearance. Present construction encloses a smaller area, and drive housing is hinged to facilitate maintenance. Machine is finished in two-tone gray. Light gray is used for main machine while dark gray is used to separate like forms and to reduce apparent size.

(continued on next page)

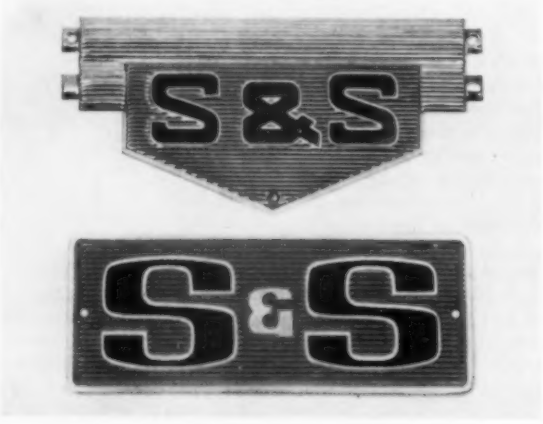


FEED AND PRINTING ROLL ADJUSTMENT mechanism components were related in shape to adjacent machine contours. Worm gear housing castings were redesigned with a simplified cylindrical form, and levers were used instead of handwheels to avoid confusion of superimposed, but not concentric, circles. Moving elements of roll drive and adjustment mechanism were enclosed in simple, but related, forms. Levers were used for all controls because adjustments are not used often and in some instances are at levels where wheel operation is awkward but handles are grasped easily.



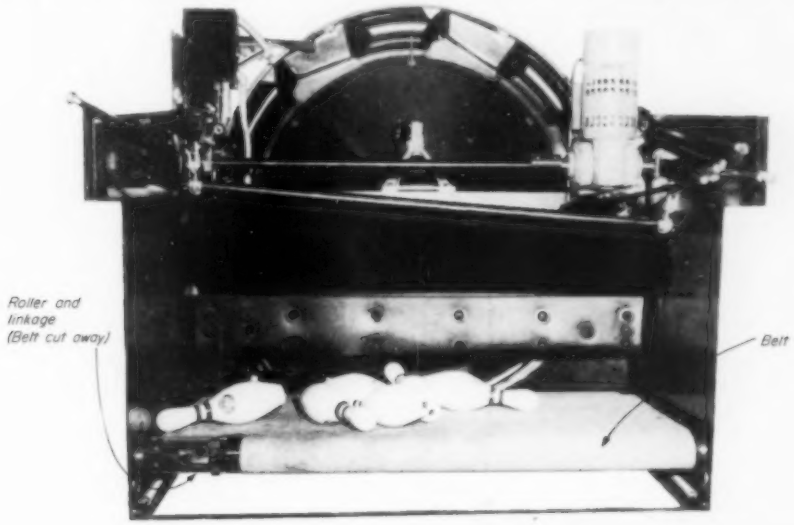
CONTROL PANEL centralizes controls for motor starting, speed control, and automatic lubrication system. It is colored to provide contrast with machine housing and carries company name and nameplate data to serve as a secondary identification area. Panel is arranged so related controls are separated by heavy ribs with a metallic finish. This is done by painting entire panel, which is an aluminum sand casting, and milling off raised portions to obtain metallic finish.

COMPANY TRADEMARK was redesigned to blend with basic rectangular form of machine and to improve recognition from a distance. Previous trademark emphasized symbol of corrugating rollers in operation and subordinated company identification. Present design retains basic theme in background corrugations, but emphasizes company identification for greater adaptability to a diversifying equipment line.

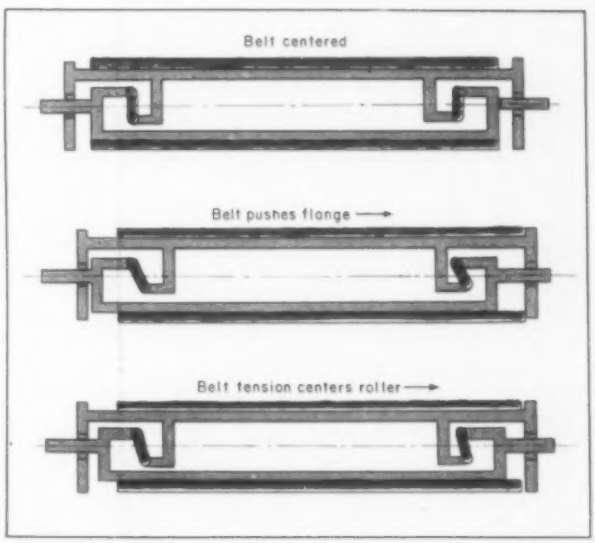


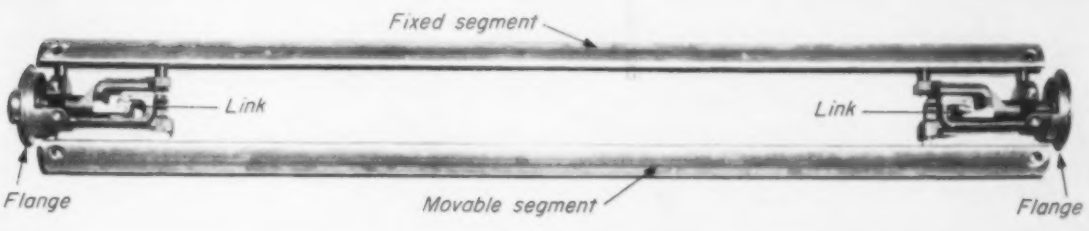
Self-Centering Conveyor Roller

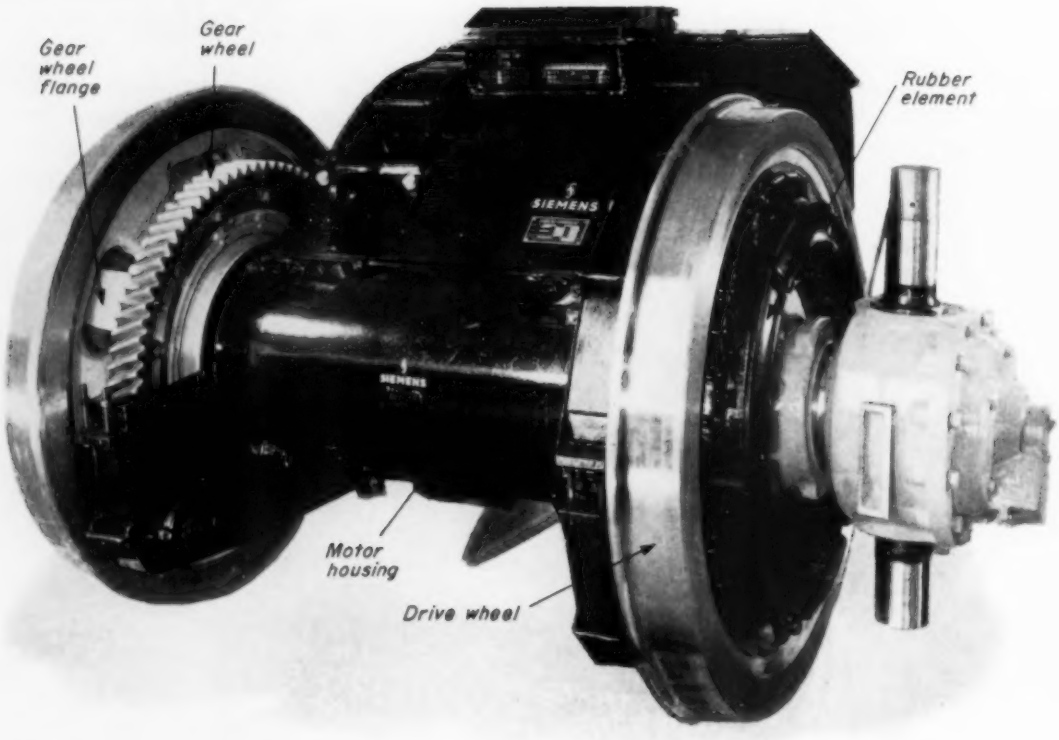
A two-section roller automatically recenters a wide belt used in the American Machine and Foundry Co. pinspotter to carry swept pins and ball into the spotting mechanism. Roller is made of two hollow half-cylinders; one segment is fixed on the shaft and the other segment shifts with the belt. Links which connect segments cause roller diameter to increase when belt pushes movable segment to either side. Belt tension forces, which increase as enlarged roller tends to stretch belt, then recenter both roller segment and belt.



CENTERING ACTION is derived from force amplification produced by elastic characteristics of belt. Belt is wider than it is long, has a pitched idler in the center which deflects ball into return chute, and carries an unevenly-distributed load. When belt moves to one side, it pushes flange of movable roller segment outward and rotates links about pivots in fixed segment. This action increases roller diameter. Belt tension force increases as larger diameter roller tends to stretch belt. Higher belt tension force tends to collapse roller to original diameter, and as roller collapses, movable section swings belt toward central position on pivoted links. Roller will function either as driver or idler. It will operate up to 150 rpm without dynamic balancing, and is suitable for operation over 500 rpm when dynamically balanced.



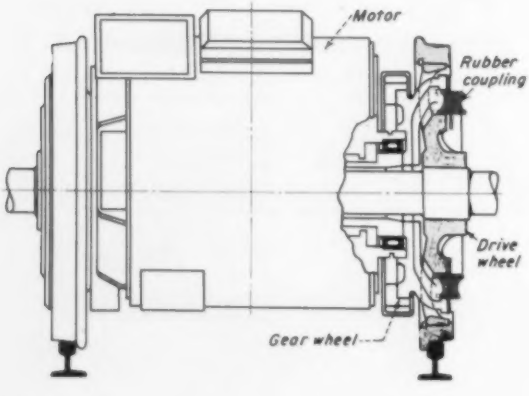




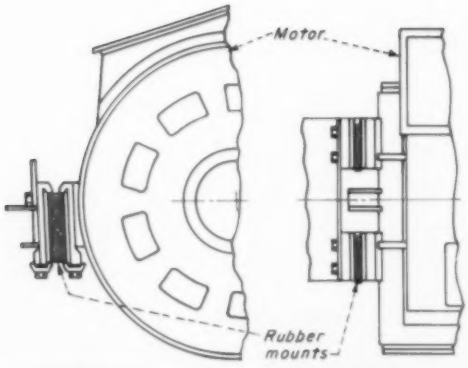
Rubber Coupling for Locomotive Drive

A coupling made of rubber ring segments transmits torque and cushions shocks in the newest electric locomotive made by Siemens-Schulkertwerke, Berlin, Germany. Ring design was selected for desirable spring characteristics. Shear stresses are low, and starting and braking torque, as well as transverse and vertical shock loads are effectively absorbed. Axle loads and locomotive speed, both previously limited by effects of vibrations, have been increased.

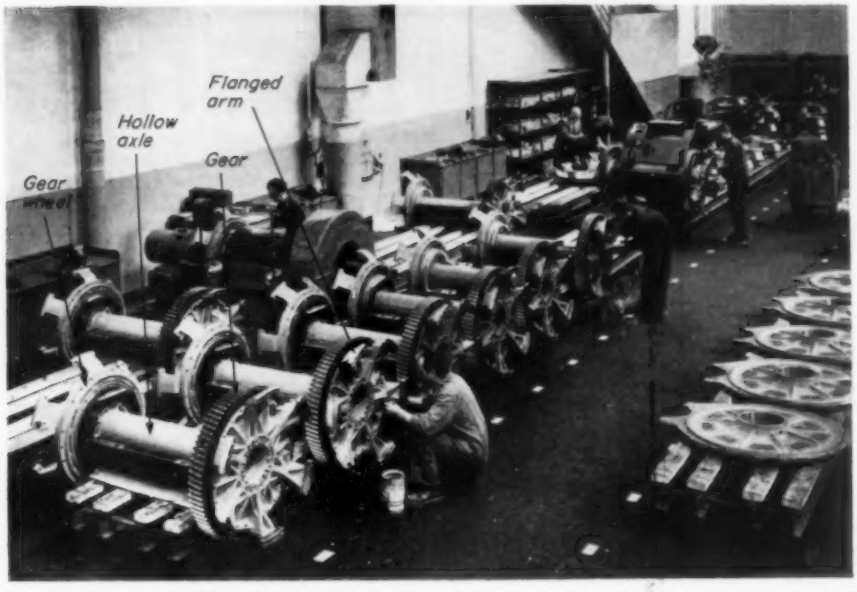
SINGLE-AXLE DRIVE UNIT houses an 1100 hp ac motor which delivers over 36,000 lb-ft of torque at full load. Motor drives two gear wheels through pinions on a double-ended shaft. Allowable axle load is 20 tons, and drive wheel diameter is 3.6 ft. Speeds over 75 mph can be attained. Coupling is made of six soft rubber elements mounted around hubs of the two drive wheels. Each element is prestressed radially in compression and is vulcanized to two steel support plates. Outside plates mount on flanges on gear wheels and inside plates are fastened to drive wheels. Dividing coupling into six segments simplifies fabrication and maintenance.



GEAR WHEELS, hollow axle, and bearing housings are assembled as a unit. Only function of hollow axle is to keep gear wheels aligned. Rubber segments dampen transverse shocks sufficiently to allow use of gear wheels thinner than those of previous models. Grease seals are protected from dust by cooling air, blown from motor, which circulates through passages (not shown) between hollow axle and bearing housing. Drippings from bearings and gearbox are discharged through radial holes (not shown) in the gear wheel by centrifugal force.

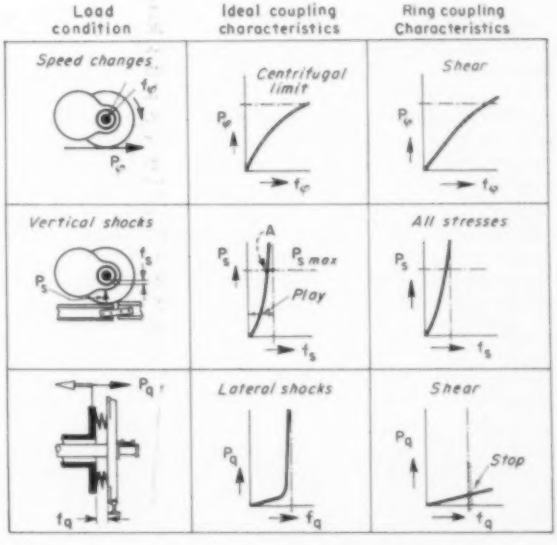


DRIVE MOTOR is pivot mounted and is partially supported by rubber coupling segments. Additional support is provided by rubber mounts between motor and locomotive frame. Two mounts are used at each end and one on each side of motor to absorb vertical and transverse shocks, and to protect motor from uneven deflection of drive wheel axle.



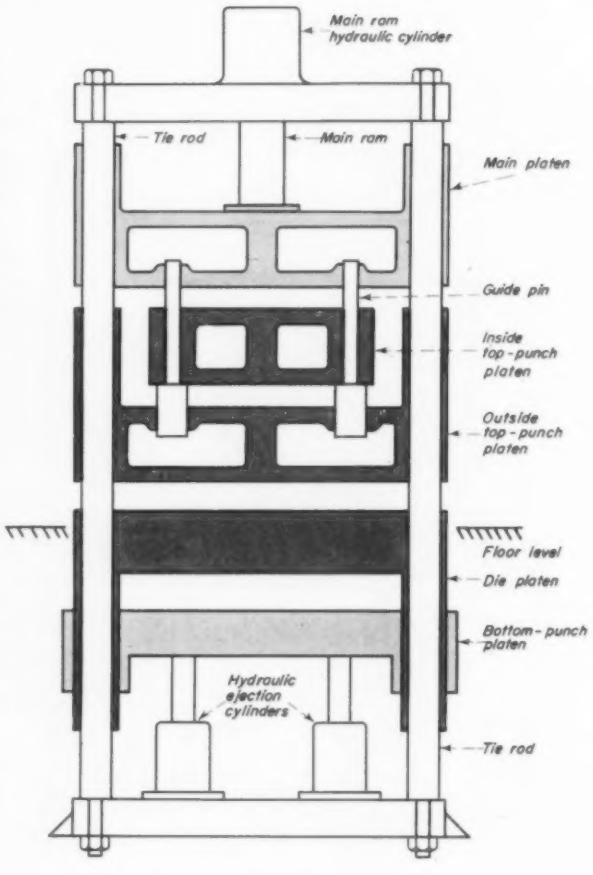
GEAR WHEEL AND HOLLOW AXLE ASSEMBLIES are fabricated on a production line. Gear ring is flange mounted on wheel and is fastened with bolts. Arms on gear wheels support outside plates of coupling segments. Holes around mounting bolts are sufficiently oversize that shocks up to 1.8 times the braking torque will not be transmitted to drive wheel. Ring coupling is subject to less than half the torsional stresses developed in other designs at speeds around 75 mph. Rubber elements are stressed in compression between 28 and 36 psi. Tensile stresses are negligible.

CHART COMPARES CHARACTERISTICS of rubber ring coupling with ideal characteristics for flexible couplings used with locomotive motors. Rapid speed fluctuations are absorbed by soft shear characteristic which also allows motor to develop maximum torque before moving drivewheel. Pulsations developed by a-c frequency harmonics while starting are also absorbed. Vertical shocks are cushioned by nonlinear and relatively stiff compression characteristic. Large shocks are generally of magnitude indicated by point A, and are absorbed in coupling without exceeding deflection limits. As horizontal shocks are normally small, a soft characteristic with a fixed stop is preferred.

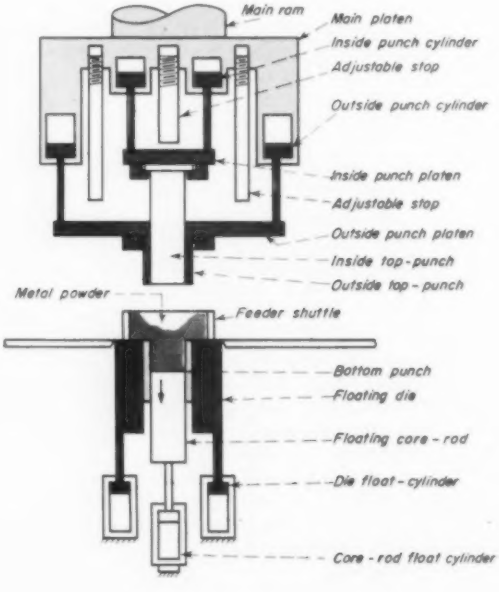


Five-Motion Metal-Powder Press

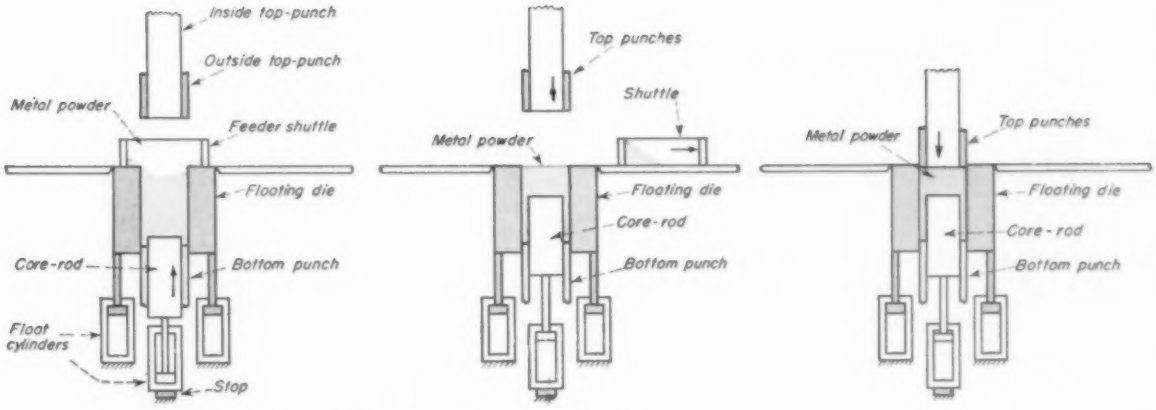
With four movable punches and a floating die holder, this press makes relatively complicated parts with simple tools. Designed by Baldwin-Lima-Hamilton Corp, the model 300-H is a 300-ton, 4-column, hydraulic press which uses auxiliary compressed air cylinders to control relative motion of the punches. Connecting inside and outside top-punch platens to the main pressing platen with air cylinders makes relative punch motion possible while pressing forces are applied by a single hydraulic cylinder. This design keeps punches synchronized and simplifies the hydraulic system.



KEEPING PUNCHES ALIGNED was a major design problem which was solved by using long sleeves to house the guide bushings. The inside top-punch platen has two guide pins which ride in bushings in the main pressing platen and in the outside top-punch platen. Sleeves on the die platen extend below the bottom-punch platen which is guided, in turn, by bushings on the outside of this sleeve. Die platen and bottom-punch platen, therefore, form a rigid unit to prevent die scoring from punch misalignment. The inside bottom punch, or core rod, is positioned pneumatically, and is guided in the bottom punch. The press is about 31 ft high, and extends about 19 ft above the floor.

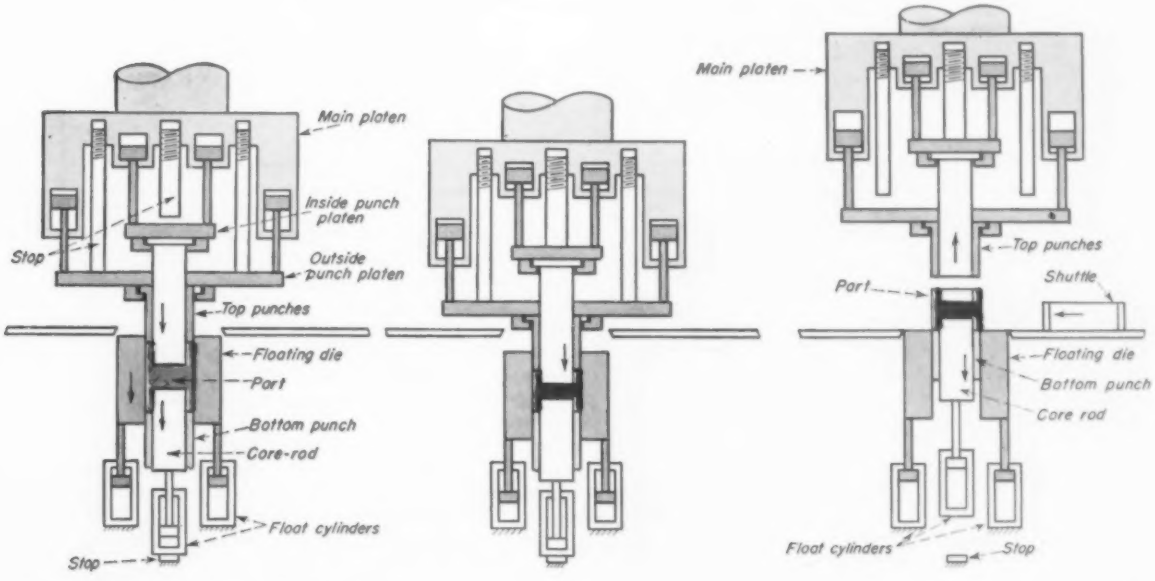


TWO AUXILIARY CYLINDERS connect each upper-punch platen to the main pressing platen. Main ram exerts a maximum force of 300 tons, while each auxiliary cylinder can exert a force of 125 tons. Cylinders for main ram and bottom punch are operated hydraulically, while top-punch cylinders and the die and core rod float cylinders are pneumatic. Adjustable mechanical stops are available to limit punch and core motions. The feeder shuttle, which transports metal powder from a hopper at rear of the press, is positioned pneumatically. It covers the die while the core rod and bottom punch move down to suck the powder into the die recess while upper punches remain stationary.



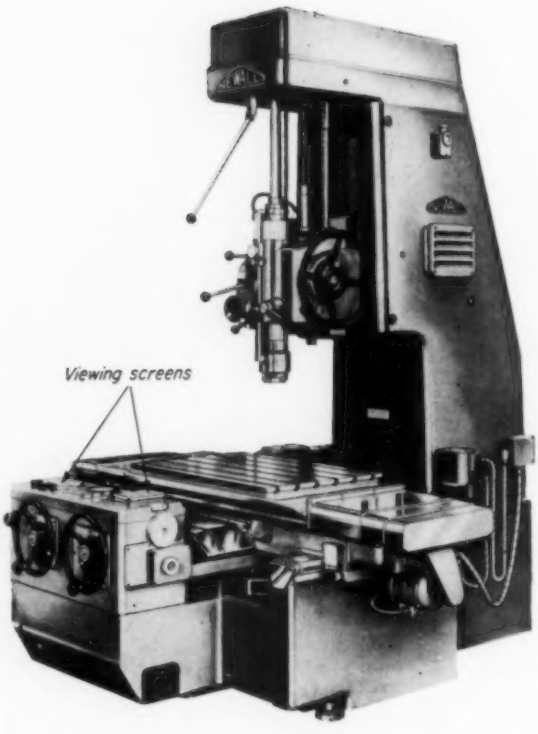
RETRACTING CORE ROD and bottom punch reduces possibility of a thin-wall condition by filling die uniformly. Next, the core rod returns to normal fill position, and the shuttle removes excess powder as it returns to rear of press. Both top punches descend and enter the die simultaneously. Air pressure in outside top-punch cylinders is adjusted much lower than pressure in cylinders of the inside punch so resistance, built up as the powder starts to compress, will cause the inside punch to move ahead of the outside punch. During this action, the floating core rod is held up by only enough air pressure to support its weight, so it moves with the top punch with little compacting of the powder above it. This action causes the outside top punch to compact powder forming lower rim of part before center and upper rim areas are compacted.

INSIDE TOP PUNCH moves at a relatively slower speed when the outside top-punch platen contacts its mechanical stops. Upper rim of the part is now compacted as the inside top punch and the core rod move toward their stops. The increased air pressure, in the cylinders which cushion the core rod and punch, gradually compacts the material between them. Friction forces between the compressed metal and the die wall cause the die to move down against the air pressure in its float-cylinders until it bottoms on an adjustable stop. As the density of the material increases, the increasing resistance to punch motion drives the core rod and inside punch against mechanical stops. Final compacting pressure is then exerted by the top and bottom hydraulic cylinders. A pressure switch, actuated by the final ram pressure, starts the ejection cycle. The main pressing platen is pulled back, clearing the punches from the die. Then, core rod, part and floating die-holder are raised by the bottom punch, or ejector platen; finally, the core rod is pulled back to the normal filling position.



Optical Micrometer In Jig Borer

An optical positioning system calibrated to 0.0001 in. which can repeat settings to 0.000025 in. has replaced a mechanical system in a jig borer made by Newall Engineering Co., Peterborough, England, with few major structural changes. Redesigned machine also features a centralized setting and control console where table settings are displayed on a viewing screen. Optical system is designed so all scales can be zeroed at any table position; also, displacements caused by variations in machine structure are not magnified. A parallel-ray light path acts as a telescopic link to accommodate cross slide traverse.



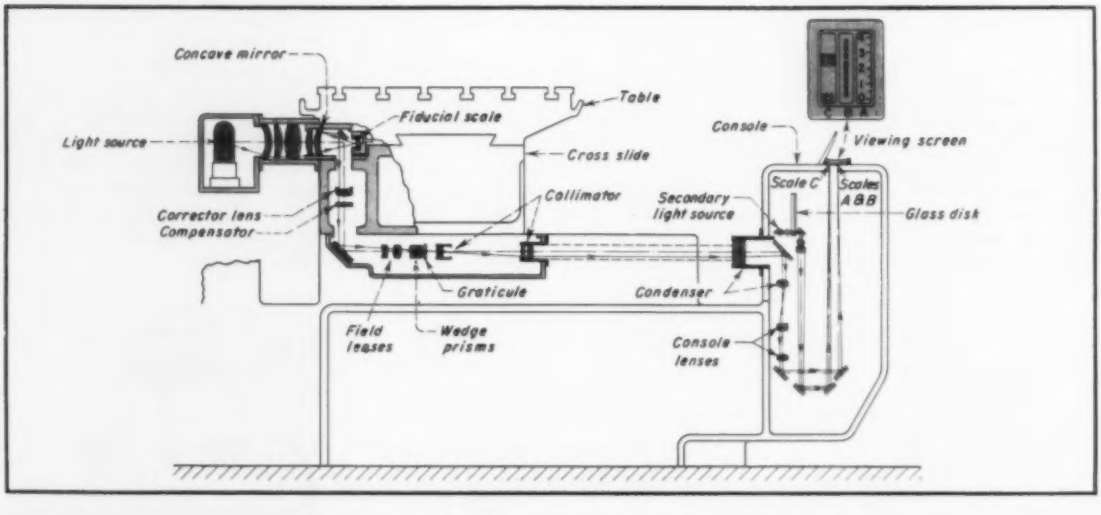
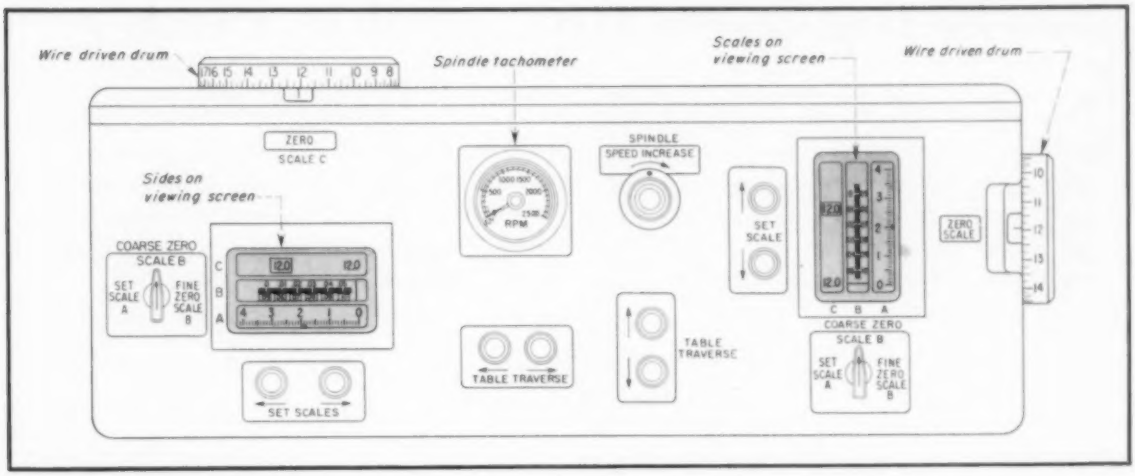


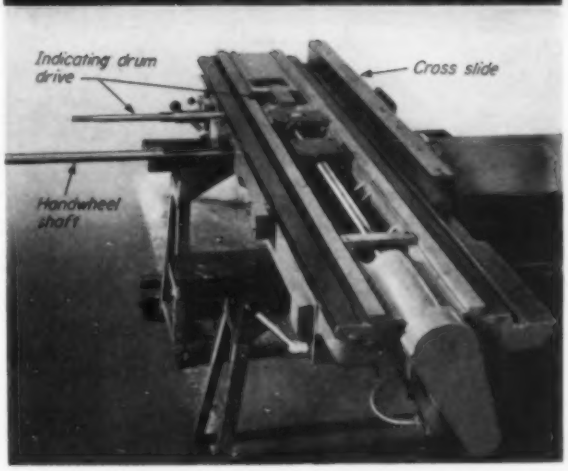
TABLE SETTING IS DISPLAYED as 3 scale readings projected onto a viewing screen. Light from mercury source is condensed onto graduated scale fixed to table and is reflected onto aluminized portion of concave mirror. Beam then passes through corrector lens, compensator, and field lenses to form a scale image on face of wedge prism. Prism moves relative to fiducial scale to form the optical micrometer. Keeping rays parallel between collimator on cross slide and condenser in console makes primary image of table scale and graticule independent of cross slide movement. Secondary image developed by condenser system at focal plane of console lenses is projected onto viewing screen scales A and B. Second optical system has a glass disk with illuminated scale numbers projected on scale C. Disk is coupled to table by a wire and drum, and rotates as table moves.

Disk can be uncoupled, zeroed, and recoupled at any table position. Scale A is zeroed by repositioning wedge prisms, and scale B is zeroed by moving field lenses, prism and collimator sideways as a unit. The graticule is fixed. This motion displaces scale line image relative to graticule in viewing window B, but does not move graticule image. As all measuring information is collected at the graticule, and subsequent elements merely transfer image to viewing screen, inaccuracies in slides or an angular shift between axes of collimator and condenser systems moves the entire image but does not change readings. Glass compensating element is rotated with a cam to change apparent length of scale image and to compensate for scale inaccuracies. A similar set of optical systems read cross slide coordinate, but do not require parallel-ray section.



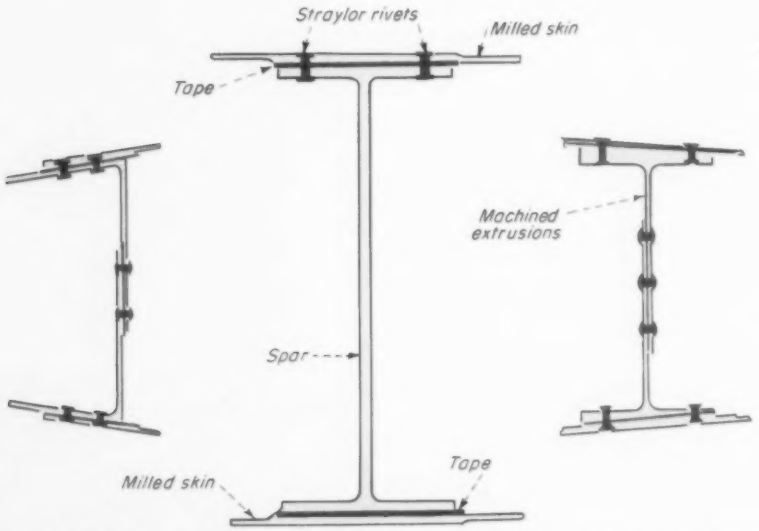
CONTROL CONSOLE contains viewing screens for table and cross slide position setting systems, spindle tachometer, and electrical controls for table traverse and zeroing of scales. Pushbuttons control rapid traverse of tables, but final settings are made with handwheels. Note that pushbuttons and scales are aligned along motion axis they control to avoid errors. On machines calibrated in English system, scale C on viewing screen reads tens, units and tenths of an inch. Scale B reads hundredths and scale A reads thousandths and tenths. Scale C readings are obtained from the wire driven drums. External drums on console are permanently connected to tables to indicate position from machine zero. Internal disks can be uncoupled and zeroed at any table position. Power driven lead screws traverse table at 90 in. per min.

BASE CASTING WAS MODIFIED by placing recesses between slide ways to make room for optical system light paths and extended to include centralized setting and operating console. Changes did not affect rigidity as ways retained original depth. Machine uses column, feed box, table and slide drive mechanisms of original mechanically-positioned design. Scale carried on table slide is spring loaded against a rigid, stationary datum surface and stays a fixed distance from optical elements. This prevents magnification of table inaccuracies. Placing scale on inside web of a channel section protects it from dust and abrasion. Rubbing faces and scale are parallel within 0.0002 in. Thermal expansion coefficients of table and scale are matched. Absolute position of tables is indicated on drums connected to lead nuts with cable. Grouping handwheels at front of console requires long splined shafts to accommodate table traverse.

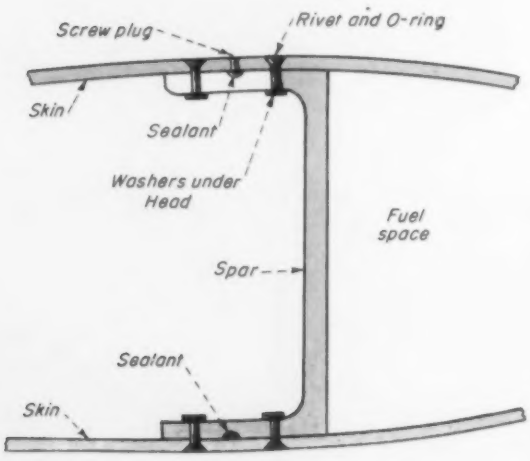


Wing Structure Holds Fuel

Tanks integral with structure solve fuel stowage problem in thin wings of Chance Vought F8U and Convair F102 supersonic aircraft. Development programs were aimed at selecting mechanical designs which remained leak-proof when subjected to dynamic structural deformations encountered in operation and selecting sealants which resist solvent and corrosive action of jet fuels at operating temperatures. Convair devised a structure sealed with heat-bonded adhesive tape, while Chance Vought uses grooves into which a plastic sealant is injected under pressure.



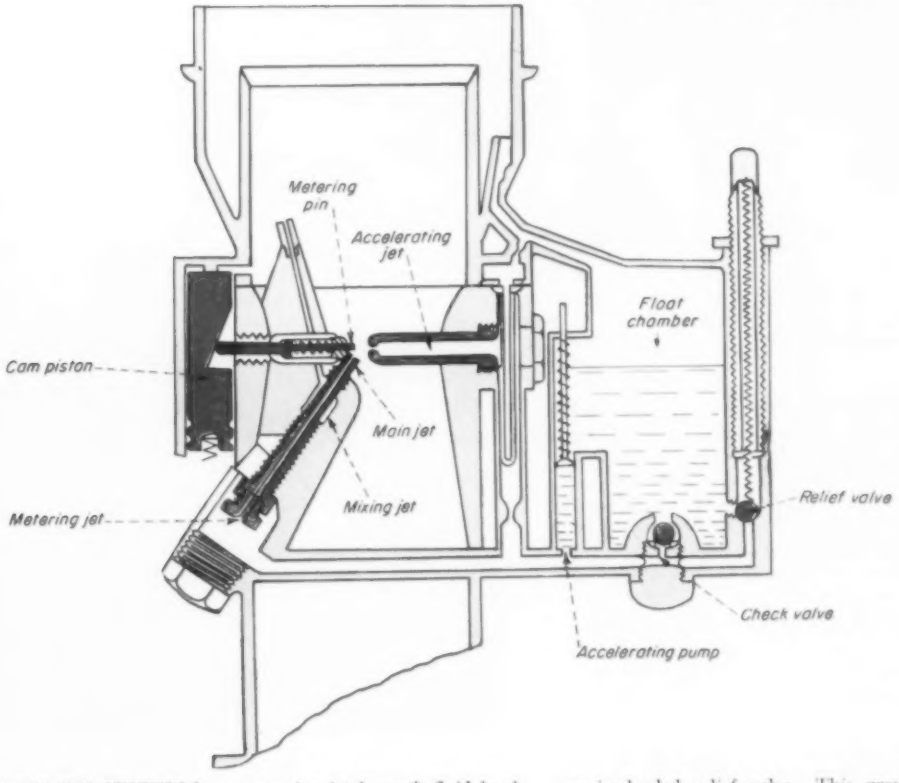
STRUCTURAL FILM, which forms a high strength bond when heat cured, is assembled in all seams of fuel space structure of Convair design. Film used is Scotchweld AF-10 developed by Minnesota Mining and Manufacturing Co. It is sandwiched between surfaces previously prepared with Alodine 600 and a prime coat of Scotchweld EC-1290 cement. Positive clamping of adhesive-filled seams is obtained with an improved flush rivet design (Straylor rivet) and by using a 0.004 in. thick aluminum foil washer under rivet head. ANC 5 bulletin was used as guide in selecting curing temperature and time cycle compatible with characteristics of 75ST aluminum alloy.



SEALANT FILLED GROOVE used by Chance Vought is adaptation of technique developed by Franklin C. Wolfe Co., Los Angeles, Cal. Groove is machined in flange surfaces of ribs and spars where they are riveted to skin. Rivets on fuel side of seal use O-rings under countersunk heads and gaskets and washers under upset ends. Joints between spars and ribs were hardest to seal, and required a bracket built on rib which fits inside flanges of spar. Clearance between mating surfaces is held within 0.002 in. to keep joint vapor-tight and prevent fuel from washing out sealant. Injection holes are drilled through skin every 3 in. and are plugged with a countersunk self-tapping screw after sealant is injected. Sealant used is PR-702, made by Products Research Corp., Los Angeles, Cal. It remains plastic between 225 and −65F.

Vacuum Actuated Pin Meters Fuel

Automotive carburetor developed in Australia incorporates a metering pin positioned by a linear cam which restricts effective openings of the main and accelerating fuel jets to meter fuel in accordance with engine requirements. Cam is cut in a piston which is positioned against a spring by engine vacuum. This arrangement makes possible accurate control of fuel-air ratio over a wide range of engine loads and speeds. Fuel forced out of accelerating pump is returned to float chamber unless engine speed and load conditions require a rich mixture. Developed by Harry Slater of Clarence Gardens, South Australia, the carburetor has resulted in fuel savings up to 17% when installed in passenger cars and trucks.



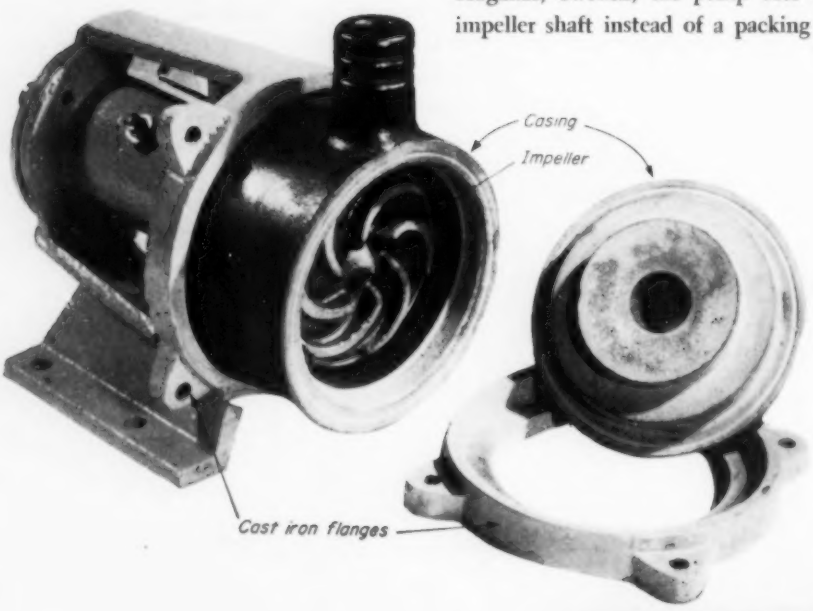
MAIN JET SYSTEM has a metering jet beneath fluid level in float chamber and a mixing jet at maximum velocity section of venturi. An air bleed (not shown) connects to main jet tube below mixing jet to premix fuel and air for better atomization. Immediately over main jet is cam actuated metering pin which, when completely extended, covers main jet and blocks orifice of accelerating jet. Both cam and pin are spring loaded to keep the jets open. Accelerating jet is positioned close to main jet and in line with cam actuated pin. This jet also has an air bleed to limit richness of mixture fed into venturi.

When jet orifices are restricted by pin, fuel forced from accelerating pump is returned to float chamber through a spring-loaded relief valve. This prevents excess fuel from being pumped into venturi unless engine speed and vacuum are such that metering pin has been withdrawn from accelerating jet. A check valve in main connection to float chamber will pass fuel in either direction at normal flow rates, but checks backflow at rates produced by accelerating pump when jets are blocked.

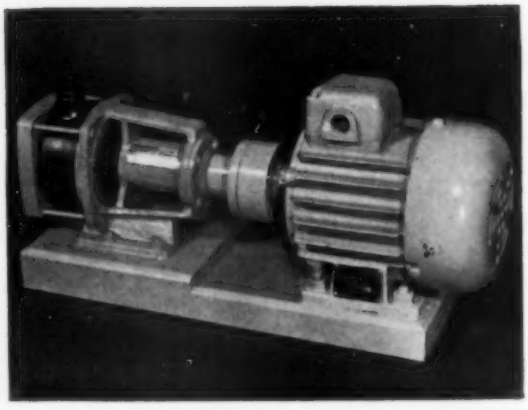
Accelerating jet acts as part of main fuel jet system over entire high speed range, as main jet cannot alone supply sufficient fuel to develop full engine power. When decelerating, fuel will not be drawn into venturi through accelerating jet as engine vacuum will pull down cam piston and extend metering pin to block this orifice.

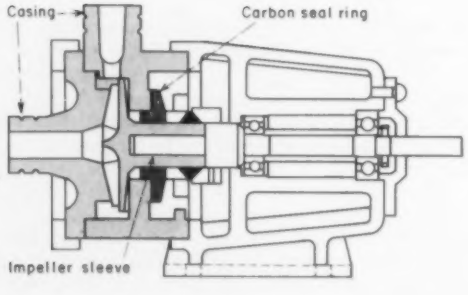
Acid-Resistant Stoneware Pump

All parts contacting pumped liquid are made of stoneware in this centrifugal pump for corrosive fluids which resists all acids except hydrofluoric. Made by Hoganas-Billesholms Aktiebolag, Hoganas, Sweden, the pump uses a carbon ring seal on the impeller shaft instead of a packing box.



STONEWARE PARTS are two-piece casing and impeller. Casing parts are clamped between flanges of a cast iron frame which protects them from mechanical impact. Normally supplied with casing designed for 1¼ in. hose connections, pump may be modified for use with flanged joints by adding cast iron adapters. Motor, base plate, and cast iron housing parts are coated with acid-resistant plastic to protect against fumes or drippings. Impeller runs between 2750 and 3500 rpm.





CARBON RING is pressed on stoneware impeller sleeve and rides against face on stoneware casing to form seal which is practically maintenance free. Fan blades on rotating carbon ring air-cool region around contact surface to prevent overheating of seal tightening components. Impeller has vanes on back surface to prevent full discharge pressure from acting against the seal. Pump is not self priming, and is designed for low-volume low-head applications. Carbon seal can be water cooled.

Plastic Case Styles Battery Tester

Socony Mobil Oil Co., Inc., provides dealers with a battery tester which has a secondary purpose of impressing customers with this extra service. Peter Schladermundt Associates increased the usefulness of the Start-o-scope by redesigning it with a functional plastic case which is also a marketing device.

TESTER INCLUDES PROD for measuring cell charge, lead for checking voltage regulators and electrical system defects, as well as water tank with syringe. Main disadvantage of original design was necessity of calibrating meter movements after assembly in metal cases which became magnetized while being spot welded. If meter was damaged, entire tester was returned to plant for re-assembly and calibration. Also, metal case rusted in normal use, and was not resistant to battery acid or weather. Although it had rubber feet, it looked like it might mar car's finish.

In new design, dial visibility, accessibility of prod storage compartment, and balance when full of water or empty were studied and improved. Case is made of plastisol for low cost, and for corrosion and shock resistance. Case is slush-molded by Sun Rubber Co., Barberton, Ohio, and assembled with electrical components by Hickok Instrument Bearing Co. in Cleveland. Surface design is applied with a silk screen.

AIR DRIVEN SPINDLES, carried in the ends of a C-shaped casting, enter the work from both ends to grind long bores of small diameter on a grinding machine made by Aktiebolaget Linham, Sweden. The shorter spindles are more rigid than a single spindle which would travel full length of the bore. Grinding time is 25% of that required with a single spindle machine, for the same accuracy.

SUBSTITUTING AN ELECTRONIC IMAGE CONVERTER TUBE for the fluorescent screen of an industrial X-ray device increased the image brilliance so greater detail is shown with less radiation. Made by Marconi Instruments Ltd., St. Albans, Herts, England, the device produces a final image in a plane mirror which is viewed with both eyes.

REVOLVING FORKS, driven by a hydraulic motor, allow Raymond straddle trucks to dump small parts from the boxes into machine hoppers. When centered, the forks are used for stacking. A manual control valve is used to rotate the forks through 360 deg in either direction.

A UNITIZED GEAR CASE containing a quill-mounted flywheel and an overhung clutch supports the main motor drive in a single action press made by E. W. Bliss Co. Except for the main gears, nothing is built into the crown. Entire drive can be removed as a unit for maintenance, and belts can be replaced without removing anything but the brake pins. Clutch can be taken off after the brake bracket is removed, and the entire quill assembly, including the clutch, can be taken out of gear case after removing six screws.

AN ANGLE OF ATTACK METER which computes the ratio between pressures at two stations on the aircraft's wing profile has been developed by R. T. Youngman, a British consulting engineer. The computed data is displayed in a cockpit presentation which indicates the optimum angle of attack for any flight condition. Advantages are direct indication of correct angle of attack without reference to gross weight data and faster response to variation from the desired angle.

HINGED TEETH ON A HYDRAULIC RIPPER, developed by Gar Wood Industries for use on the Euclid TC-12 crawler, can swing through 180 deg while the tractor maneuvers.

AN AUGER WITH A HOLLOW STEM, used in a mobile rotary earth drill made by Mobile Drilling Inc., Indianapolis, Ind., makes possible the taking of undisturbed soil samples without removing the drill from the hole.

AN ELECTRICALLY HEATED GROOVED CYLINDER aligns and polishes fibers to produce a fur-like effect on high-pile fabrics. Heat and pressure may be set to suit the fabric, and are controlled automatically. Machine is made by Turbo Machine Co., Lansdale, Pa.

Drafting Costs are *GOING UP*

They're 70% of total engineering expense . . . Why?

WILLIAM H. BYRNE
Byrne Associates, Inc.

Vacations, sick leave, coffee breaks, upgrading, labor turnover, print checking and other innovations have fantastically increased the cost of operating a drafting room in the past twenty years. Most of these costs are uncontrollable; others can be reduced.

Let's compare costs today and in 1935 or earlier. To establish a basis for comparison, lost time and other extra costs have been estimated and converted into paid non-productive man-days per man-year. Net cost listed below each item represents the difference in man-days between lost time before 1935 and today.

Decreased Working Week

With the advent of the five-day week, normal effective working time probably decreased an average of 4 hours per week. Actual records indicate that weekly pay has not decreased proportionately. Based on the recollections of some old-timers and the records, it appears reasonable to estimate that the actual lost non-productive time value of weekly pay is 2 hr per week (50% of the average 4-hr reduction). At 2 hr per week the loss is 104 hr or 13 working days per year.

Net Cost: 13 man-days

Holidays

Prior to 1935 there were approximately 6 paid holidays. Holidays today add up to the equivalent of 10 paid working days, or a difference of 4 non-productive paid days.

Net Cost: 4 man-days

Vacations

Prior to 1935 an employee received one week's vacation after one year. Today's policies give two weeks of vacation. Prior to 1935 vacations for all employees averaged about three days per employee in the drafting room. Records for the past year (despite turnover) approximate 9 days, or a difference of six paid working days.

Net Cost: 6 man-days

Lateness, Slow Starting

Old records indicate that when a man was 15 min late in starting work, he was docked 30 min. In this day of shortage, when a man is late, his employer is more likely to be concerned that the man may have left to take a job with a competitor. The same applies to quitting time. In the old days draftsmen were ready to start at starting time and did not pick up before quitting time. Today this is not so. To measure this, a test survey was made without the knowledge of personnel. The results were:

Lateness: 14%–15 min late; 33%–10 min late; 10%–5 min late; 43%–not late. Computed average 6 min.

Slow Starting: 77% required approximately 10 min after arrival to get started; 23% were ready to start on time. Computed average 8 min.

Early "Pick-Up": 22%–15 min before quitting time; 24%–10 before; 18%–5 before; 36%–at quitting time. Computed average 7 min.

The foregoing represents an average loss of slightly more than 21 min per day, the equivalent of 11 days per man per year. Squad leaders, when conscious of this, have been effective in reducing the loss. Records indicate a loss of approximately 1 day per man in this category prior to 1935.

Net Cost: 10 man-days

Excused Absences

Either men were healthier in the old days or they just accepted loss of pay when they were out. In any event, prior to 1935, the over-all average of paid excused absence per man was slightly less than 1 day per year. Current records average 5 days per year.

Net Cost: 4 man-days

Coffee Time

Prior to 1935, there were no allowances for coffee time. A current survey showed this: 50% of the men went out twice a day for a total of 38 min; 28% went out 1½ times a day for a total of 30 min; 11% went out once a day for about 15 min; 8% once in a while with an average of 20 min each time; 3% did not go out. The average loss of time per man per day was slightly over 27 min, the equivalent of 14 days per man per year.

Net Cost: 14 man-days

Labor Turnover

One of the largest factors contributing to lost time in the drafting room is turnover. This includes cost of recruiting, breaking-in time, separation time and the less-tangible effects of releases and resignations on general productivity.

Records are available that reflect comparative conditions of employment in 1928-29. These are placed side-by-side, with an average of three companies for the year 1955-1956.

Date	1928–29	1955–56
No. of Employees	375	820
Total Additions	165	680
Release for Cause	24	75
Release by Resignation	21	343
Total Releases	45	418
Net Additions	120	262
Additions retained, %	73.0	38.6
Cost of Employment		
Advertising	$2,600	$66,936
Reference to Investigation	210	760
Fees, etc.	.....	1,560
Separation Allowances, etc.	980	9,420
Personnel Dept.	4,330	18,000
Interviews	1,200	20,400
Entertainment	.....	1,300
Travel Expenses	110	3,230
Activities—Picnics, etc.	.....	3,000
Miscellaneous	100	4,200
Total	$9,530	$128,806
Cost per Net Employee Added	$79	$492
Increase		$413

The total increase in cost for net additions is $413 × 262 = $108,300. Distributing this cost over the total number of employees; $108,300/820 = $132 per employee on the payroll. Assuming an average daily rate of pay of $24 per employee, the cost changeable to the average employee is 132/24, or 5½ man-days.

Net Cost: 5½ man-days

Breaking-In Time

Two chief draftsmen, each with more than 30 years of experience, were consulted about present and past breaking-in time. Their estimate was that it required about 2 weeks less to bring a new man to production par prior to 1935. However, in view of the fact that quite a few men hired are former employees, only half of this estimate (1 week) is allowed for each new man hired. On the basis of 227 new employees, the total lost time is 1135 days. With an average of 273 employees on the payroll, cost per average employee is 4 man-days.

Prior to 1935, when notice had been given, there was seldom loss of production. Today, assuming 2 weeks notice, it may be safely estimated that with each release another week of productivity is lost per man. Total lost time for 139 released men is 5 × 139 = 695 days. Averaged over the 273 employees, the cost is 2½ man-days.

Greatest effect on productivity is from the unrest caused by continual turnover. Review of production records indicates that production time is longest in groups with greatest turnover. On the assumption that other separately calculated items will have an effect on this, a guided guess would estimate 5% loss of production rate to be expected from high turnover effects. This decreased production rate indicates also that replacements are less efficient than older men lost by competitive recruitment. It also reflects job hunting and gossiping time not otherwise accounted for. On the basis of a 236 day year, 5% represents a loss of 11½ man-days.

Summing the four losses chargeable to turnover as equivalent paid nonproductive days:

Net Cost: 23½ man-days

Upgrading

This is not a difficult factor to diagnose or compare with the previous period. It results directly from the unethical or unwise policies used by some companies in their efforts to obtain employees. In order to meet such competition, unrealistic advancements in grade must be given and rates of those already on the job must be raised in order to avoid losing men. A recent review was made of two companies employing 680 men. The basis for determination as to whether or not the men were upgraded was comparison of salary paid with salary that would be considered normal to the job specification.

Upgraded By	Percentage of Employees	Added Cost
15 to 25%	7.8%	156.0%
10 to 15	12.9	162.0
5 to 10	23.8	178.5
0	55.5	0.0
	100.0	496.5

This is an average of 495.6/100 or 5%, representing an equivalent of 13 additional nonproductive paid days per man in the drafting room.

Net Cost: 13 man-days

Overtime

Normal practice today requires a minimum of 6 hr overtime per week in order to hold or hire personnel for the drafting room. The average in most companies is about 8 hr. Records indicate that approximately 90% of the men work overtime.

Continuous overtime is not efficient and a fair rate of productivity in such overtime would be 50%. On this basis for 12 hr pay each week (time and a half for overtime) a man works 4 productive hours. On the basis of a 50-week year and 90% of the men, this totals 45 equivalent days lost per year. In the old days, overtime was at straight time and was the exception and not the rule. Therefore, to be on a comparative and conservative basis the difference is arbitrarily reduced to 35 days per year.

Net Cost: 35 man-days

Fringe Benefits and Taxes

Average fringe benefits for social security, unemployment, pension plan, insurance, taxes, etc., cost between 6 and 9% of the salary. An average of 7% is approximately 18 days. In the prior period most of these did not exist and the only so-called fringe benefit was insurance costing less than 1% or 3 days.

Net Cost: 15 man-days

Lateness . . . excused absences . . . coffee breaks: 28 days pay.

Employee Activities

Many extra activities are encouraged to keep employees happy and improve their professional and social status. Bowling, baseball teams, picnics, Christmas parties, engineering society dues, expense accounts, school, and others are supported by progressive companies. Some even give bonuses to the employees for "pirating" others. In any event according to one company's records this amounts to about 1½%.

Net Cost: 4 man-days

Load Factor

Prior to 1930 usual front-office instructions were to release men when not needed even though only as a temporary layoff. The result was that generally drafting rooms operated at say 99% annual load factor. Today, most companies, because of changing levels of demand and the difficulty in replacing a man once released, run on an annual load factor of about 97%. This 2% difference is equivalent to an increase in nonproductive paid time of 5 days per year per man.

Net Cost: 5 man-days

General Productivity

Level of drafting competence is definitely lower today than it was prior to 1935. This is the considered opinion of two 30-year men and comparative production records seem to support this claim. As a test, a selected squad of top-flight men were assembled and without their knowledge compared to another squad made up of a fair group comparable in pay level. Both took advantage of coffee breaks, etc. In fact, the better squad had more sick and incidental absences yet their production in square feet of drawing was 16% better.

To rate the average payroll of today with that prior to 1935, an arbitrary index number was assigned to excellent, good, fair and poor ratings. Experienced draftsmen then estimated the percentage of the payroll in each category for the two eras and an average index was calculated.

Rated Productivity	Prior 1935 %	Prior 1935 Weight	Subsequent 1954 %	Subsequent 1954 Weight
Excellent — 100	35	3500	10	1000
Good — 90	45	4050	35	3150
Fair — 75	15	1125	45	3375
Poor — 60	5	300	10	600
Average Production Index		89.75		81.25

Inefficient overtime: 35 days pay.

This 8.5 index point difference closely approximates the test run. It appears that today's production requirement, disregarding all other factors, indicates an average of 9.5% loss based on current working days. It is computed to be equivalent to a loss of 20 days per year.

Net Cost: 20 man-days

Checking Manufacturer Prints

Review of a control record indicates that an average of approximately 16% of total drafting-room time is consumed checking manufacturer prints on power and chemical plant projects. The detailed checking required is a development of recent years. Apparently manufacturers have unloaded on the engineer a lot of details formerly handled by them. According to recollection and observation, today's requirements, particularly those relating to increased distribution of prints, are at least twice those of prior 1935. This is an 8% difference or nearly 19 days per year per employee.

Net Cost: 19 man-days

Decreased Manufacturers Services

Today more design is done in the drafting room than was done prior to 1935. Manufacturers have reduced the scope and detail of equipment layouts, etc. It was estimated that this added at least 5% to the job, or say 12 days per year per employee.

Net Cost: 12 man-days

Technical Specialists

Developments in high temperature, pressure, stress analysis, electronic control, slab construction, etc., have resulted in the need for technical specialists. Generally these command premium rates even though part of the time the load factor may be low. Analysis of a payroll indicates that if regular designers rather than technical specialists had done the work, as in the old days, a saving of approximately 1½% on an over-all basis would have resulted. This is equivalent to 3 days per year per employee.

Net Cost: 3 man-days

Drawing Details and Number of Drawings

More drawings are required today with more detail than prior 1935. This is largely a result of the increased complexity of equipment, construction requirements and technological advances in the thinking of many engineers and designers, some of whom lack field experience. The only measure I could develop on this was the comparison of two similar jobs, generally not too involved—one under the direction of a small old-time consultant in 1937, the other under the project engineer of a large engineering organization in 1952. Final results, with due allowance for other factors, were: 1937—37 drawings, 762 man-days designing and drafting time; 1952—46 drawings, 1472 man-days designing and drafting time.

These jobs were selected to illustrate this situation. However, even after allowing for more experienced leadership and direction, the difference is too great. Subsequent check of construction costs did not reveal advantages in either. To be conservative, an over-all difference of 10% was allowed. This is equal to 24 man-days per year per employee. The records do not bear this out directly, and some of the procedures initiated no doubt minimize it. However, to call attention to it, it is calculated as an allowance of 5 days.

Net Cost: 5 man-days

Supervision and Clerical

Prior to 1935 it was usual for the majority of squad leaders to be working squad leaders generally reporting directly to the chief draftsman. Today's involved problems, changing conditions and other factors have made it necessary and advisable in larger organizations to have a section leader for each department—mechanical, electrical, structural, architectural, etc., each having several squad leaders under him. Further, whereas formerly squad leaders, to a large extent, handled the time records, possibly assisted by a junior draftsman, today's practice because of the involved accounting systems and other factors has resulted not only in the building up of clerical forces but in increased supervision. A large part of the clerical work is in

connection with the recording of prints and making delivery. Somewhat incomplete data combined with memories of some of the old-timers leads to the opinion that at present twice as much time is required. Analysis of records shows that combined drafting-room supervision and clerical time opproximate 20% of the total time. On this basis, 10% of total time can be considered in excess of the prior 1935 period, which is equivalent to an over-all average of, say, 24 man-days per year per man.

Net Cost: 24 man-days

Engineering Changes and Revisions

This is a difficult factor to evaluate as it varies with each job. On an over-all basis, it was found to be equivalent to 9% of the total. This divides about 5% for changes and 4% for engineering delays, awaiting print approval, manufacturers' delays, changes from delivery schedules, etc. Again old timers figure today's changes to be three times those of the old days and delays to be fully twice as much. This would indicate a 5% penalty on today's operations or roughly 12 man-days per year per man.

Net Cost: 12 man-days

Prints

Today's practices in many large engineering organizations require that 50 to 60 blueprints be struck off during the course of a single drawing. This is twice as many prints as was the practice prior to 1935. Assuming an excess of 30 prints per drawing and an average in the drafting room of 9 drawings per man per year, this would amount to about $270 per year or the equivalent of 11 paid man-days.

Net Cost: 11 man-days

Coordinating and Expediting Time

The necessity of meeting due dates, expediting revisions, expediting delayed manufacturers' prints, expediting prints awaiting approval, numbering production records for production control, writing reports, requests and many other duties necessary for an efficient operation have developed the need for a coordinator in the drafting room to work with, but not necessarily under, the chief draftsman or project engineer. This has materially helped in production planning and keeps the chief draftsman informed yet releases him from the necessity of maintaining such records and handling many of the vexing details. However, this has added to costs of obtaining drawings. This cost is estimated to be about 1½% of the drafting-room payroll or on an equivalent basis approximately 4 man-days per man in the drafting room.

Net Cost: 4 man-days

Project Engineer

The ability and attitude of the Project Engineer has much to do with drafting time. Drawing times of a large number of jobs involving approximately 1800 drawings were reviewed. In this connection, with the assistance of the squad leaders, chief draftsmen, coordinators and chief engineers the various engineers handling the jobs were rated. They fall into three groups—which though somewhat controversial, provides an answer.

Engineer Rating	Relative Dwg. Time	Per Cent of Projects
Better than average..	92%	37
Average.....	100	44
Poor.....	126	19
		100

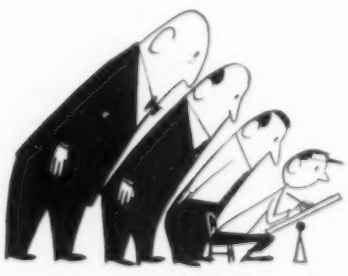
A weighted average indicated that despite the large difference in relative production, the over-all effect was only 2% or the equivalent of 5 man-days per man in the drafting room. While the over-all result spoke well for the average rating of the engineer, it graphically shows what the effect could be with a preponderance of poor engineers.

Apparently, equal in importance to degree of knowledge and experience is the engineer's ability to hold the good will of drafting personnel. Though records do not readily establish a figure for this and since such an answer might be reflected, in part, in the item on productivity, to emphasize this effect 5 days are charged to the Project Engineer.

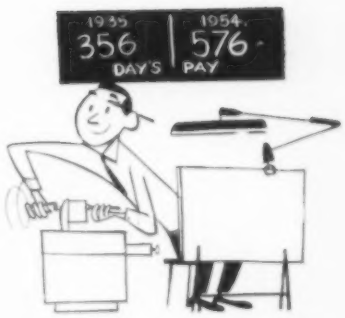
Net Cost: 5 man-days

Summary

Based on these calculations and assuming that currently there are about 236 working days per year, as compared with 278 prior to 1935, and further than overhead accounts do not absorb any attributable drafting-room cost, then the table below indicates the relative manpower comparison in equivalent time.



Supervision . . . associated clerical help: 24 days pay.



Total drafting cost; 1935 and today.

	Prior 1935	Subsequent 1954
Productive Time.	278	236
Nonproductive Time	78	340
	356 Days	576 Days
Ratio	1.00	1.62

Drafting rooms therefore require 62% more paid hours now than they did 25 years ago. If the reducible items could be fully corrected, this percentage would drop to 18%. Assuming only a 50% correction of such reducible items to be practicable, paid man-hours have increased 41%.

What About Salary Levels?

Data for prior years are not entirely complete, but a factor of 3.0 times is a good average and closely matches general industry wage increases:

Comparison of Salaries (40-hr week)

	1925–1930	1955–1956
Chief Draftsman	$65—85	$225—300
Assistant Chief Draftsman	60—75	190—240
Squad Leader	50—70	155—190
Designer-Checker	40—55	140—175
Draftsman-Senior	35—50	110—145
Draftsman-Junior	25—30	70—100

If a reasonable estimate of increased paid man-hours is 1.41, and of increased salaries, 3.0, **the total drafting cost is now 4.23 times what it was before 1935.**

This analysis is intended only as an indication of what has happened and to call attention to places for improvement. It is to be expected that many readers will disagree with these estimates, yet no matter what method is used, results should be comparable because these figures are representative.

Anodized Aluminum Molds Make . . .

CASTINGS AS STRONG

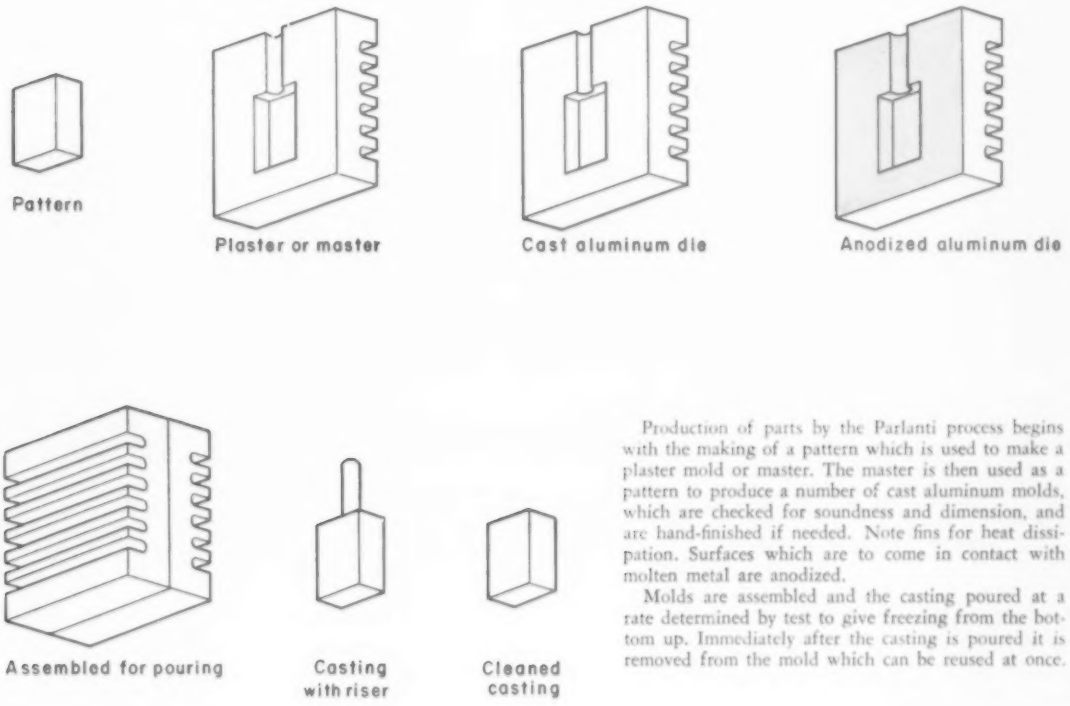
For parts that can be made by conventional methods either as castings or forgings, castings are lower in cost particularly in small quantities where die costs are large, but forgings with higher physical properties can be designed for small size and weight. Castings with the physical properties of forgings are now possible through the use of anodized aluminum molds with a special pouring technique giving progressive freezing from the bottom up. The new method is applicable to all usual casting alloys based on steel, cast iron, magnesium and aluminum.

The process differs from sand casting in using a metal mold, and it differs from permanent mold casting in controlling both metal feed rate and cooling pattern. The results are improved and uniform properties throughout the casting, elimination of such internal defects as porosity, shrinkage and pipe, and freedom from surface and subsurface defects. Reduced machining time and good surface finish are added advantages.

Size and Shape of Parts

Steps in the process are shown in detail here. There are no inherent limitations to the size of castings that can be made by this process. Largest casting yet made on a producion basis, over 5 ft dia, was cast in an aluminum alloy and weighed 350 lb. Even larger castings have been produced successfully on a development basis. At the other end of the size scale is an aluminum turbine blade less than 2 in. long and weighing $\frac{1}{3}$ oz.

There are some limitations in the shape of the parts the process can produce. The use of a metal mold leads to shapes closer to those produced by forging or permanent mold than by sand casting. Intricate external shapes do not present any difficulty: undercuts and irregular surfaces are possible by using split or multiple molds. Internal cores give greater difficulty, and part design must make provision for extracting the core. Coring of holes is not recommended as freezing metal sets up stresses which may tear or warp the casting.



Production of parts by the Parlanti process begins with the making of a pattern which is used to make a plaster mold or master. The master is then used as a pattern to produce a number of cast aluminum molds, which are checked for soundness and dimension, and are hand-finished if needed. Note fins for heat dissipation. Surfaces which are to come in contact with molten metal are anodized.

Molds are assembled and the casting poured at a rate determined by test to give freezing from the bottom up. Immediately after the casting is poured it is removed from the mold which can be reused at once.

New type of mold construction combined with controlled pouring rate is adaptable to large or small castings in aluminum, magnesium, cast iron, steel

AS FORGINGS

CONRAD A. PARLANTI, *Chief Engineer*
Niforge Engineered Castings, Inc.
Boston, Mass.

Castable Alloys

While not all casting alloys have been tried, and little work has yet been done on copper base alloys, no difficulty has been encountered with light alloys, steels and superalloys.

Cast iron was one of the first materials extensively cast by this process, many thousands of mortar bombs having been produced in Britain during the war.

Carbon and stainless steels also cast well, stainless steels of an austenitic nature (18-8 type) being more suitable than the martensitic or low-nickel types.

Magnesium alloys are uniformly satisfactory, including those for high temperature applications with zirconium, thorium or other rare-earth additions. The rapid cooling action prevents segregation or migration and agglomeration of the alloy additions.

Aluminum alloys can be cast readily, alloy 195 giving somewhat better results than alloy 356.

Nimonic and similar high-temperature alloys have been cast into turbine blades without difficulty.

Stellite and other superalloys are now being investigated. No difficulties are expected.

How the Process Works

The process makes use of the high thermal conductivity of aluminum to control both the direction and rate of heat transfer from the molten metal. The mold is made of aluminum, and the face which comes in direct contact with the molten metal is deeply anodized. The anodized layer has a melting point of over 3700 F, and is also hard and therefore resistant to erosion and wear, making possible repeated use of the mold.

Being a refractory material with low thermal conductivity, the anodized film momentarily checks the flow of heat from the metal being poured, keeping it from freezing too soon. Net result is that the metal which is first poured into the mold is the first to freeze, so

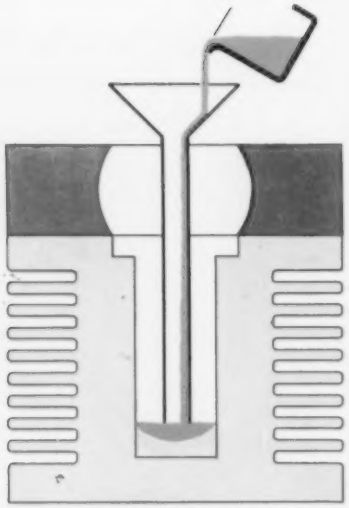


Fig. 1—To pour this casting, the molten metal is admitted gradually through the refractory funnel which rests on the liquid surface and is withdrawn as the freezing line rises in the mold. Solidification starts at the bottom, leaving only a small pool of liquid metal which is fed by the incoming stream. By the time the liquid level reaches the riser, the casting has solidified. Rate of heat dissipation is increased by fins.

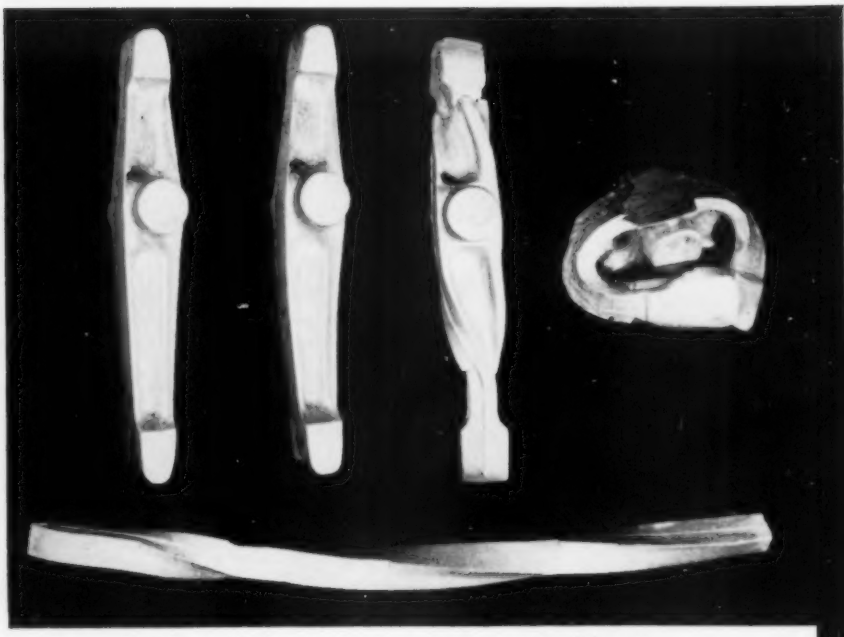


Fig. 2—Ductility in bending of aluminum castings produced in anodized aluminum molds. Aircraft lever (top) left to right: as cast, bent, twisted, bent pure aluminum. Bar (bottom) has dimensions of $\frac{1}{4}$ x $\frac{1}{4}$ x 18 in. No cracking of bar is discernible.

that controlled pouring produces progressive solidification of the part from the bottom up, the last to freeze being the riser. Pouring time, however, is seldom over 30 sec, even for large parts.

The solidification process, Fig. 1, results in a dense casting, while the high cooling rate produces fine grain, both characteristics contributing to the improved mechanical properties of parts produced by this process.

Comparison with Other Casting Processes

Low thermal conductivity of the mold in sand, plaster, and investment casting processes prevents the start of metal solidification until the casting is completely poured. Even after the metal has filled the mold, heat dissipation is at a low rate, and solidification starts at the skin of the casting and proceeds inward. This slow solidification promotes the formation of large grains and a dendritic structure.

As cooling progresses, metal next to the mold is the first to cool and forms a shell which becomes stronger as the temperature falls. At the same time, the metal shrinks as it cools. By the time the metal at the center of heavy sections solidifies it has more space than it can fill. As a result, voids occur, which can coalesce into sizable cavities. Properties at the center of heavy sections are invariably lower than at or near the skin.

Metal molds used in diecastings and permanent mold castings limit casting alloys to those with a melting point substantially lower than that of the mold metal. Freezing from the surface in permanent and diecasting molds produces low properties in the center of heavy sections.

Mechanical Properties

Test bars machined from both the thin and the heavy sections of castings produced by the anodized mold process give appreciably higher strength along with a large increase in ductility as compared with other casting methods. Typical values are given in Table I for a comparison of the new process with permanent mold on three aluminum alloys. Note that ductility (elongation) is at least double that of other processes. Fig. 2 shows the deformation required to

TABLE I MECHANICAL PROPERTIES OF ALUMINUM CASTINGS

Alloy	Nominal Composition	Condition	Type of Mold	Tensile strength, psi	Yield strength psi at 0.2%	Elongation %
195	4.5 Cu, 0.8 Si	Heat treated	Permanent	45–48,000	40–45,000	1–2
		As Cast	Anodized	55,000 min	45,000 min	6–8
355	5 Si, 1.3 Cu, 0.5 Mg	As Cast	Permanent	30–32,000	13–15,000	2–3
		As Cast	Anodized	32,500	20,000	8
356	7 Si, 0.3 Mg	As Cast	Permanent	26–30,000	14–16,000	3–4
		As Cast	Anodized	35,000	20,000	24

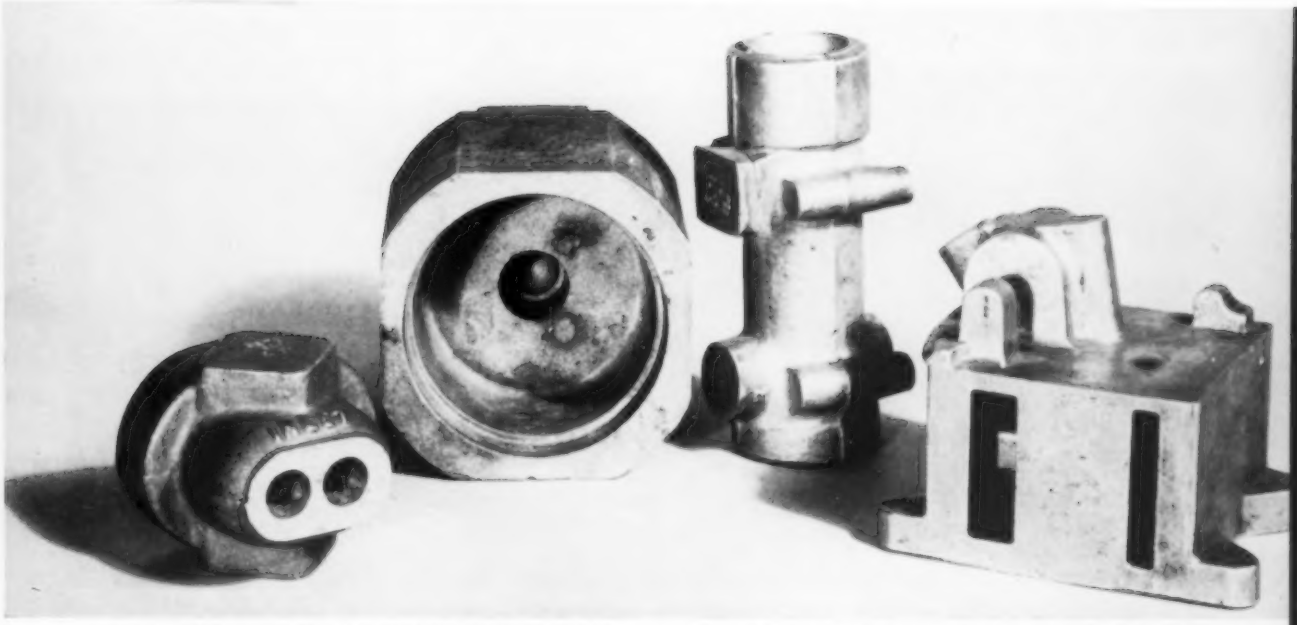


Fig. 3—Design must allow for extraction of metal cores from casting. Parallel cored holes in pump body at extreme left increase casting cost. Recesses in pump body at extreme right are $\frac{3}{4}$ and $\frac{1}{2}$ in. wide by $3\frac{1}{8}$ in. deep. The two pump bodies at left and the one at the extreme right are for service with an internal pressure of 4,500 psi. Hydraulic cylinder center operates at an internal pressure of 10,000 psi. These castings were taken at random from production runs.

Surface finish of a casting is dependent upon intensity and duration of reaction between mold and molten metal. In sand casting, prolonged cooling time of the cast metal results in production of relatively large quantities of gas which must be allowed to escape: hence the requirement for permeability of the sand mold.

With anodized aluminum molds no such reaction occurs, but the mold surface does tend to adsorb and hold some atmospheric gases, hydrogen being the worst offender. When the casting is poured, the occluded gases are released by the mold and are entrapped at the surface of the cooling casting, producing a minutely mottled effect. These gases can be released by heating the mold in a vacuum. Improvement in surface finish depends on the degree of vacuum and duration of treatment.

break the specimens. Increase in tensile strength and elongation comes from soundness of the metal as cast in the anodized aluminum molds and rapid cooling which produces a uniformly small grain size.

Design Data

Parts to be cast by the anodized mold process are designed more like forgings than sand castings, but more precision of detail and greater intricacy of shape can be obtained.

Cores should have a minimum taper of 3 deg. Parallel cores are possible, Fig. 3, but increase the cost of the casting, as special provision must be made to allow for core movement as the casting freezes. If the part is cast in iron, steel or other metal with a melting point considerably higher than aluminum, a disposable aluminum core may be used, Fig. 4.

Minimum wall thickness of $\frac{1}{16}$ in. can be easily maintained if design of the part allows for adequate flow of metal to the thin section. Fillets and corner radii must be large enough to allow the part to free itself from the mold on cooling, and should never be less than $\frac{1}{16}$ in.

Surface finish of aluminum and magnesium castings is about 125 microinches. On iron and steel castings surface finish ranges from 125 to 250 microinches, depending on size of casting. Finer finishes can be obtained at increased cost by reworking the mold after each casting is poured. Wave guides, Fig. 5, have been cast successfully, with internal surface smooth enough to be used as cast.

Advantages and Limitations

Mechanical properties in castings obtained by the process permit reduction of section size, particularly

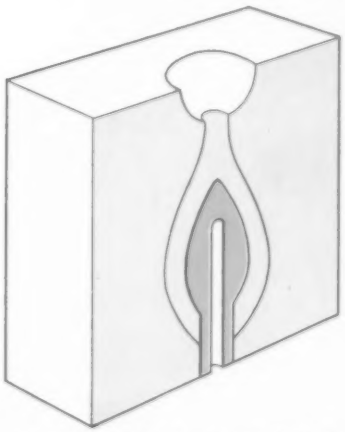


Fig. 4—In this mold for a cast-iron shell, the aluminum core is so designed that it does not quite reach its melting point until the casting solidifies; heat from the casting then raises the temperature of the core above the melting point, and the core melts and flows out.

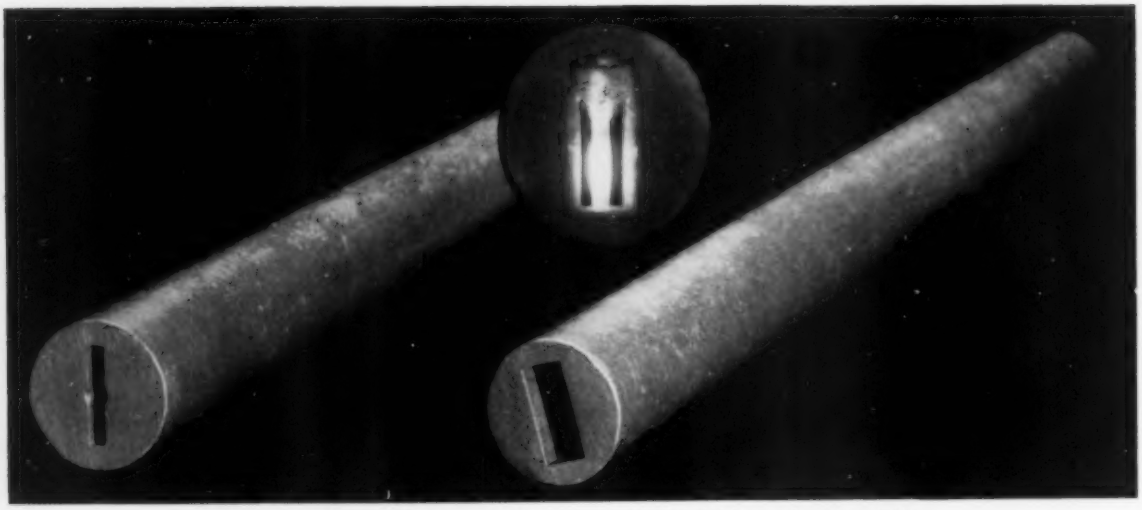


Fig. 5—Surface finish in cored holes duplicates the finish on the core. This wave guide 20 in. long is produced with a surface of 16 microinch or better.

important in applications requiring high strength-to-weight ratios.

Uniformity of properties from casting to casting, through use of the same mold to produce many castings, eliminates the most important source of variation occuring in non-reusable sand molds.

Accurate reproduction of detail, arising from the unyielding characteristic of the mold, can cut machining time substantially.

Casting production rates are high, requiring less skill than is needed in other casting processes.

Rigidity of the cores and the high rate of heat transfer also open up new range of possibilities in design such as the part shown in Fig. 6.

Limitations arise from the necessity of extracting cores from the casting and castings from the mold. Also, a mold has to be developed for each part, and the cost of this pattern-and-process development may approach the cost of developing forging dies.

EDITOR'S NOTE: The causes of unsoundness in magnesium sand castings were treated in "Quality and Cost of Magnesium Sand Castings," March 1957 page 164.

Other recent articles on casting include "Casting Design," October 1956 page 190, "Designing for Investment Casting," April 1956 page 166, "Frozen Mercury Process for Investment Castings," Design Digest, Mid-October 1955 page D13, and "Redesign for Die Casting," January 1956 page 156.

"Evaluation of Casting Processes," March 1954 page 139 provides a valuable background to the present article.

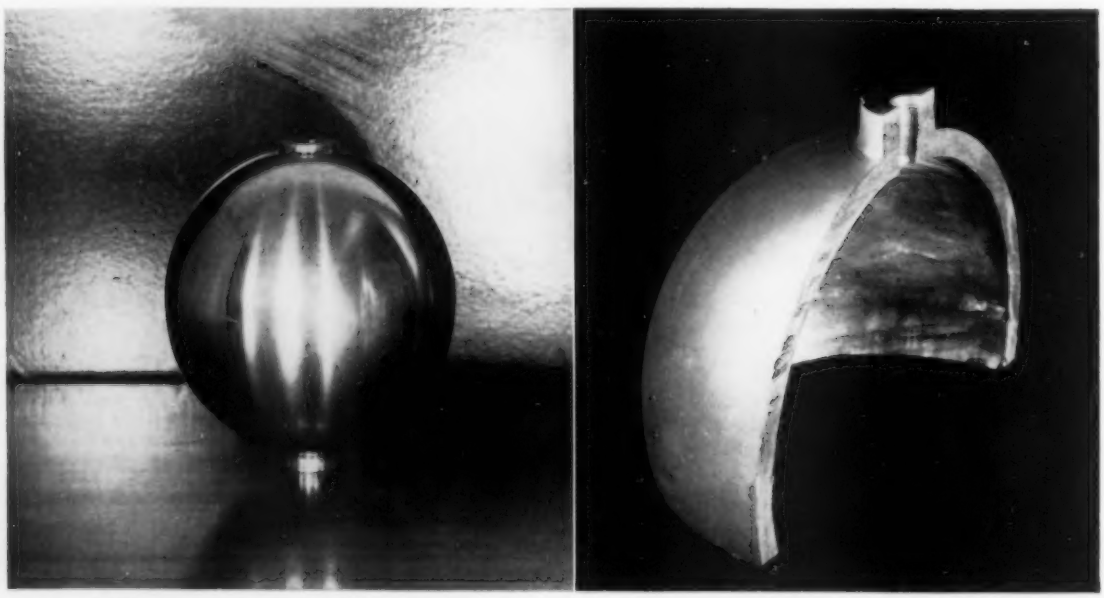


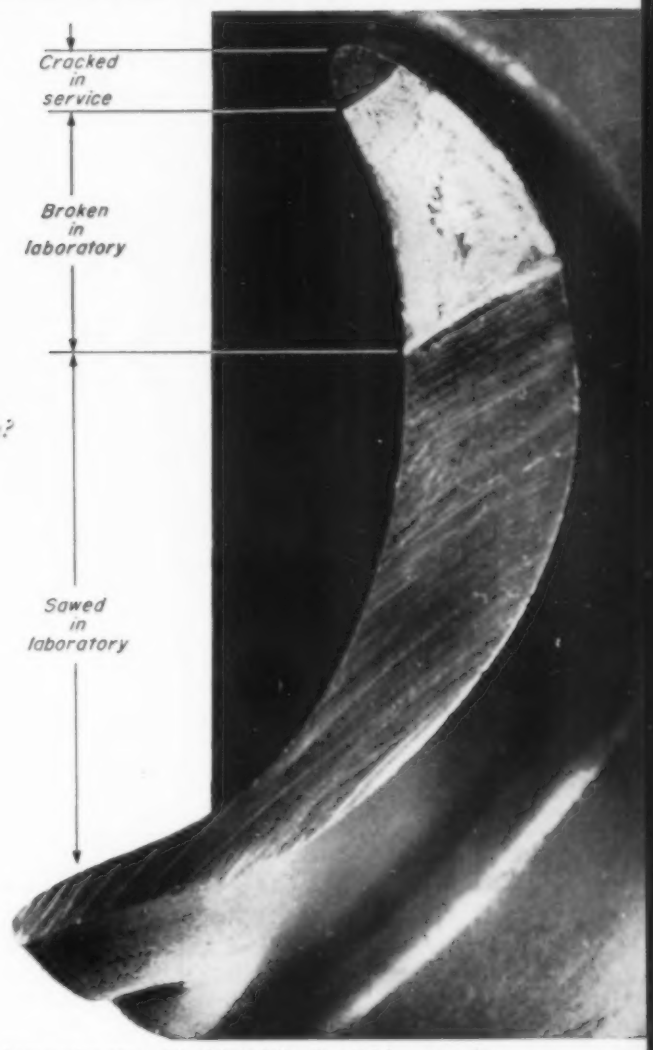
Fig. 6—Hollow castings can be made around a sheet metal core which remains in place. This aluminum sphere 7 in. dia was cast with a $\frac{1}{4}$ in. wall thickness; outer surface has been machined.

FIVE
CURRENT
QUESTIONS:

1. *where do thermal stresses originate?*
2. *when is thermal stress fatigue important?*
3. *how are materials evaluated for thermal shock?*
4. *why is thermal stress fatigue different?*
5. *what design criteria should be used?*

THE ANSWERS ARE IMPORTANT *because . . . .*

Higher operating temperatures accentuate premature failure in structural parts. The culprit may be . . .



Locomotive gas turbine blade fails after 100 hrs operation because of crack initiated by thermal stress fatigue.

Thermal Stress Fatigue

DR. L. F. COFFIN, JR. *General Electric Research Laboratory*

NUCLEAR reactors, jet engines, missiles, rockets, steam power plants, automotive gas engines—even forging dies and permanent molds—all of these modern products face repeated temperature fluctuations. Relatively high working stresses result, and may cause early failure similar to fatigue, even at room temperature.

Most suitable materials and safest stress levels are selected by considering such basic factors as mean temperature, range of temperature, number of cycles, and the effect of constraints and applied loads. Transient temperature distribution in the part is also very important.

The main difference between mechanical and thermal fatigue is the part played by ductility in the stressed component. Relation between modulus, thermal conductivity and coefficient of expansion forms a useful criterion in selection of materials for thermal shock. Thermal stresses are lower in materials combining low modulus, low expansion and high conductivity—titanium, for example. Thermal stresses in structures are produced by varying temperatures in various areas, which cause difference in expansion, or by materials with differing coefficients of expansion within the part. Thus thermal stresses are intimately associated with temperature distribution. Sharp temperature gradients in brittle materials such as ceramics often cause cracking.

Metals deform under excessive stress, and it is this plastic flow which prevents sudden brittle failure. Plastic flow from excessive thermal stress, however, introduces the problem of thermal stress fatigue—ultimate cracking of a ductile material caused by fluctuat-

ing thermal stress. Thermal stress fatigue cracks in a mold are shown by the impression in the glass tumbler of Fig. 1.

Thermal Shock Parameter

Significant factors for estimating the relative resistance of materials to thermal stress are elastic modulus, thermal conductivity and coefficient of expansion. There is, however, no universal parameter applicable to both steady-state and transient-temperature problems. One useful parameter for steady-state considerations is the quantity $E\alpha/k$, where E is the modulus of elasticity, α is the linear-expansion coefficient, and k is thermal conductivity. A high value for this parameter indicates a susceptibility to high thermal stresses, while a low value indicates the converse. Thermal shock parameters are given in Table I for various structural metals. Note that molybdenum gives the lowest value, while austenitic steel of the 18Cr-8Ni variety gives one of the highest values.

Determining the relative susceptibility of the materials to thermal stresses under transient temperature situations is more complicated. Boundary conductance and dimensions assume significance in determining magnitude of the thermal stresses. If boundary conductance and geometry remain constant, the parameter may be used in comparing materials for thermal shock resistance. This parameter is particularly useful for screening brittle materials where failure can occur from a single severe thermal shock. Materials with lower values have greater resistance to thermal shock, Table I.

Role of Thermal Cycling

How materials fail by thermal fatigue is illustrated by Fig. 2, which is a simplification of material behavior when subjected to cyclic thermal stresses. Temperature of the material is held constant throughout with respect to time, and the specimen (A) is pushed back and forth between two fixed positions. The hysteresis loop (B) occurs after several cycles of deformation with the straight-line portions of the loop representing elastic behavior.

In thermal fatigue, the material is first pushed in

TABLE I — COMPUTATION OF THERMAL SHOCK PARAMETER FOR METALS AND CERAMICS

	Calculation Temperature, deg F	Elastic Modulus, E psi x 10^6	Expansion Coeffficnent, α in/in/F x 10^{-6}	Thermal Conductivity, k Btu/hr/sq ft/F per in.	Thermal shock Parameter, $E\alpha/k$
METALS					
Molybdenum	1400	42	3.8	770	0.21
Nickel	1000	28	8.3	420	0.55
Titanium	1000	12	5.4	96	0.67
AISI 1020	1000	24	8.2	250	0.79
AISI 410	1000	25	7.7	205	0.94
AISI 347	1000	23	9.6	150	1.47
CERAMICS					
B_2O_3	1800	44	5.0	139	1.6
MgO	1800	30	7.5	49	4.6
TiC–C_{sf}	1800	60	5.0	58	5.2
Al_2O_3	1800	51	4.9	44	5.7

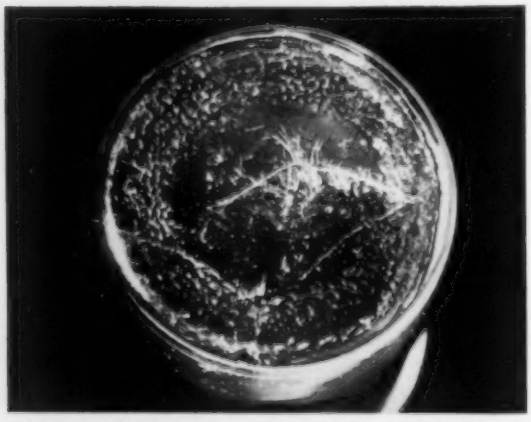


Fig. 1—Glass-tumbler mold, cracked by thermal fatigue, left this image in the bottom of a glass picked up at a cocktail party.

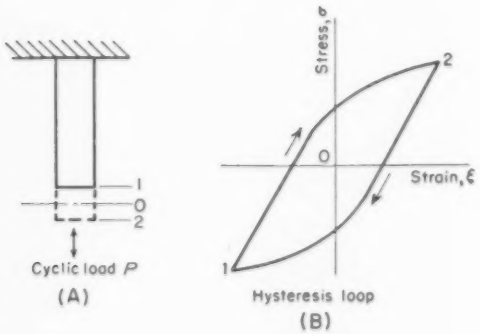


Fig. 2—Material behavior under cyclic thermal stress. Temperature is held constant, and specimen deformed cyclically between 1 and 2. Repetitive reversals of plastic strain lead to fatigue failure.

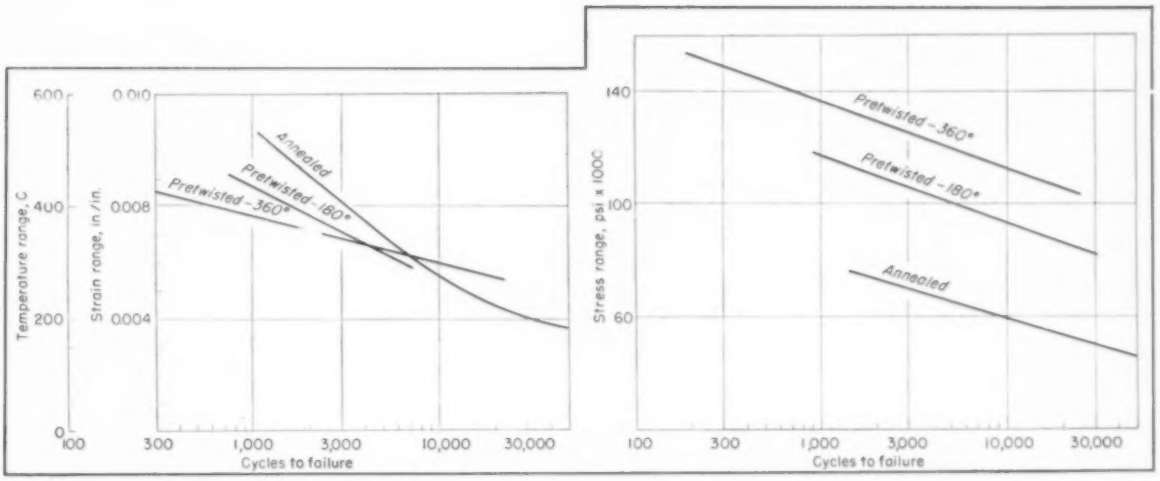


Fig. 3—Thermal stress fatigue behavior of Type 347 stainless showing effect of prior cold work. Note that for low strain ranges, annealed material fails first.

Fig. 4—Mechanical stress fatigue behavior of Type 347 stainless showing effect of prior cold work. Here, cold work results in longer life for all stress ranges.

one direction elastically, then plastically; then reversed, first elastically, then plastically to its original dimensions. Cyclic elastic action produces no effect on the material; however, the plastic part of the loop does change the material properties, although there is no net change in dimensions. The cyclic plastic process is manifested by progressive development of slip bands within each grain. This leads to formation of a crack, at first very small, which grows until the whole specimen fails. Thus, cyclic plastic action is the culprit which produces failure.

Thermal stress cycling is a cyclic strain problem. This is the basic difference between thermal fatigue and mechanical fatigue. Although cyclic stress is related to cyclic strain, stresses in thermal fatigue are generally in the plastic range and are not linearly related to strain. Further, thermal stresses arise because differential expansions cannot occur freely in the structure. These expansions are the product of expansion coefficient and temperature change and have the units of strain. Thus, when thermal stresses in excess of the yield strength are dealt with, the problem must be considered in terms of strain rather than stress.

Material Behavior

Several tests have been devised for studying the behavior of materials under cyclic thermal stress. In one, an arrangement similar to Fig. 2(A) is used. A test specimen is held rigidly between immovable ends, then alternately heated and cooled between preset temperature limits. Because it can neither expand nor contract, longitudinal thermal stresses are developed in the sample, first compression, then tension. The stresses are proportional to the expansion coefficient and the temperature range. With this simplified test, many of the parameters in thermal stress fatigue have been investigated:

Constrained thermal cycling causes metal fatigue failure. The number of cycles to failure is related inversely to the temperature range, the curve being similar to conventional fatigue data, as shown in Fig. 3 for Type 347 stainless steel. The temperature range times the thermal expansion coefficient gives the strain range; hence this is a cyclic strain problem. High thermal stresses are permissible, however, if the number of application cycles is limited in design.

Ductility is more important than stress level, Fig. 3. When the temperature range is high, failure occurs earlier with increasing cold work. On the other hand, when the temperature range is low, the reverse effect takes place; the material with the higher amount of prior cold work withstands a larger number of cycles. This is contrary to conventional fatigue behavior where, under the application of cyclic loads, material with prior cold work is always more resistant to fatigue (Fig. 4) regardless of the magnitude of the stress imposed on the material.

Increasing the mean temperature while maintaining the temperature range lowers the thermal fatigue resistance of a material (Fig. 5 for Type 347 stainless). Prolonged exposure to elevated temperatures and stress cycling cause changes in the unstable structure of the metal. Apparently, the combination of cyclic temperature and cyclic stress accelerates the processes leading to premature structural faults in metals. Much more work is required here.

Frequency of thermal cycling also plays a role. In thermal stress fatigue, however, frequency is considerably lower than in conventional fatigue. For example, in a steam piping system one cycle a day or a week might be expected, while in forging, 20 or 30 cycles a minute may be the maximum. Experimental data on Type 347 indicates, Fig. 6, that the lower the frequency, the fewer the cycles required for failure. This is to be expected because the longer it takes to develop a hysteresis loop, the more time there will be for plastic deformation to occur at high temperatures through creep or relaxation processes. And cyclic plastic defor-

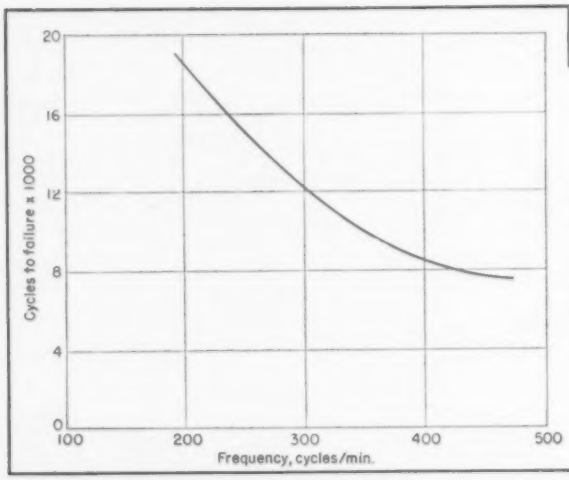


Fig. 5—Effect of mean temperature on thermal stress fatigue resistance of Type 347 stainless.

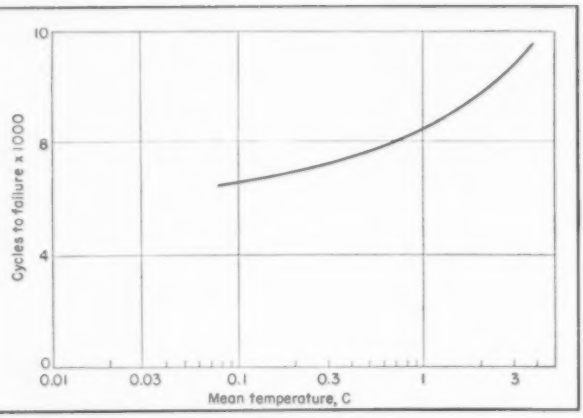


Fig. 6—Effect of frequency on thermal stress fatigue of Type 347 stainless steel.

mation produces failure in the majority of such cases.

Nature of the stress cycle has little effect. For example, the simple test described here produces compression when temperature rises to its high value and tension when the low value is reached. In a steam pipe bend, however, the bending-stress distribution may be such that increasing temperature produces tensile stress and decreasing temperature produces compression. Tests indicate that the kind of cycle makes little difference in the life of the part.

Design Criterion

High thermal stresses may be tolerated in a structure if the number of thermal cycles can be limited. A basic relationship exists for representing thermal stress fatigue failure from which a useful design procedure can be constructed. The allowable number of cycles N is related to the amount of plastic strain $\Delta\epsilon_p$, which occurs at a given point by the following equation:

$$N^{1/2}\,\Delta\epsilon_p = c$$

This relation holds for all ductile materials examined to date. Constant c varies with the material. Table II lists constants for several widely used structural materials.

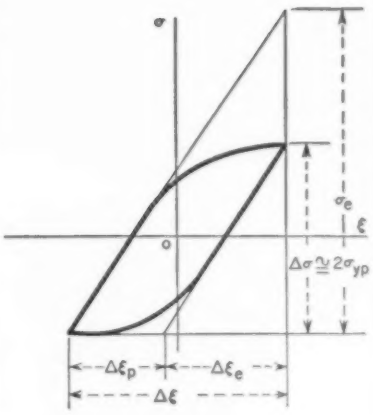
The equation and its use are best understood by the hysteresis diagram in the sample problem (see box). This diagram represents the stress-strain condition at a single point in the structure during thermal cycling. Stress range $\Delta\sigma$ and strain range $\Delta\epsilon$ are simply the vertical and horizontal dimensions of the loop. Total strain range $\Delta\epsilon$ is the sum of the elastic strain range $\Delta\epsilon_e$ and the plastic strain range $\Delta\epsilon_p$. If $\Delta\epsilon_p$ is known, the allowable number of cycles, N, may be easily computed.

TABLE II — MATERIAL CONSTANT vs MEAN TEMPERATURE

MATERIAL	Mean Temperature					
	70 F	400 F	570 F	660 F	930 F	1110 F
AISI 347	0.96	0.78	....	0.68	0.59	0.44
AISI 1020	0.46	....	....	....	....	....
1.7 Mn steel	0.48	....	....	....	....	....
2.5 Ni Cr-Mo-steel	0.42	....	....	....	....	....
3.0 Cr-0.4 Mo steel	0.60	....	0.56	....	0.43	....
13 Cr steel	0.62	....	0.60	....	0.57	....
2011 aluminum	0.88	....	....	....	....	....
2024 aluminum	0.35	....	....	....	....	....
5.0 Mg aluminum	0.30	....	....	....	....	....
OFHC Cu	0.88	....	....	....	....	....

Nomenclature

N	Number of thermal cycles
$T_2 - T_1$	Temperature range
$\frac{T_2+T_1}{2}$	Mean temperature
$\Delta\sigma$	Total stress range
$\Delta\epsilon$	Total strain range
$\Delta\epsilon_e$	Elastic strain range
$\Delta\epsilon_p$	Plastic strain range
σ_e	Calculated elastic thermal stress
σ_{yp}	Yield strength of material
c	Material constant (Table II)



Basic thermal stress fatigue relation:

$N^{1/2}\Delta\epsilon_p = \text{constant}$

Example:

The temperature in the exhaust port of a diesel engine cycles from 700F at idle to 1200F at full load. Stress analysis shows that a thermal stress of 120,000 psi is developed in the 13 Cr steel port liner. Estimate the approximate thermal fatigue life of the liner.

1) Elastic thermal stress:

σ_e = 120,000 psi (from elastic analysis)

2) Equivalent total strain range:

$\Delta\epsilon = 120{,}000/30 \times 10^6 = 0.004$ in./in.

3) Assuming yield is not exceeded, elastic strain range:

$\Delta\epsilon_e = 2 \times 30{,}000/30 \times 10^6 = 0.002$ in./in.

4) Plastic strain range:

$\Delta\epsilon_p = \Delta\epsilon - \Delta\epsilon_e = 0.002$ in./in.

5) Number of cycles to failure:

$N^{1/2}\Delta\epsilon_p = c = 0.57$ (See Table II)

$N^{1/2} = 0.57/0.002 = 285$

$N = 81{,}000$ cycles

The plastic strain range $\Delta\epsilon_p$ can be approximately determined by this procedure:

(1) Compute the elastic stress σ_e caused by the total temperature change, assuming the material does not yield, even though the stress so calculated is well in excess of the yield strength.

(2) Convert the calculated elastic thermal stress to a strain by dividing it by the modulus of elasticity. This strain is assumed to be equal to the total strain range $\Delta\epsilon$.

(3) Compute the elastic strain range by assuming that the material in reality can never exceed the mean temperature yield strength in tension or compression. Thus the elastic strain range $\Delta\epsilon_e$ is taken as twice the yield strength divided by the modulus of elasticity.

(4) Determine the plastic strain range $\Delta\epsilon_p$ by subtracting the elastic strain range computed in (3) from the total strain range found in (2).

(5) Calculate the allowable number of cycles N from the basic thermal fatigue relation using the appropriate constant c for the material. The number of cycles can be reduced by a suitable safety factor, if desired, to account for uncertainties in stress calculation, operating conditions (such as frequency), and material properties.

Status of Problem

This procedure has been used with considerable success in a variety of design structures, from gas-turbine buckets to nuclear-reactor components, cases where rather severe thermal stress conditions prevail. Two other examples are electrical fuses and quenching of steel plate:

Ordinary household fuses often fail by thermal stress fatigue. When the electrical load fluctuates widely and repeatedly, the fuse will fail even though the line load is maintained well below the rating of the fuse. Here, the current alternately heats and cools the fuse element slightly with fluctuations in the load. Expansions and contractions thus produced lead to cracks, reduction in element area, overheating and failure of the fuse.

Quenching of steel plate is also an example of transient thermal stressing, which often does more damage than steady state heat exchanges. If the thermal stress in the plate at any time exceeds the yield point at that temperature, plastic flow will occur. The plate will then have some residual stresses when quenching is complete, whereas following elastic quenching the plate would be stress-free.

Importance of thermal fatigue is being recognized more widely. Recently, the ASA Code for Pressure Piping was revised, to account effectively for the cyclic nature of the stresses in piping systems. The Pressure Vessel Research Committee in recent years has carried out extensive investigations on material and component temperature strain cycling to establish design procedures for more reliable structures.

EDITOR'S NOTE: Other recent articles in the current series on the behavior of metals at elevated temperatures include:

"High-Temperature Materials," September 1956 page 186, reviews early development, alloy systems available, properties required, methods of evaluation and trends.

"Metals at Elevated Temperatures," October 1956 page 160, discusses the basic question of what are elevated temperatures. Influence on a variety of metal properties, relative importance of fatigue and rupture strength, predicting long-time behavior from short-time data.

"High-Temperature Stainless Steels," April 1957 page 135, presents mechanical properties, structural stability and fabrication of five austenitic and three martensitic alloys.

13 Rotary-Pump

SIGMUND RAPPAPORT *Project Supervisor, Ford Instrument Company Adjunct Professor of Kinematics,*

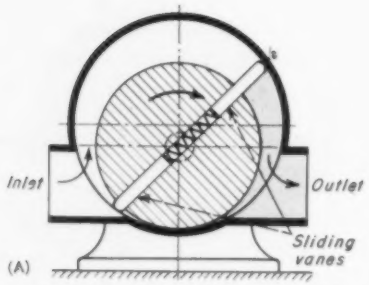
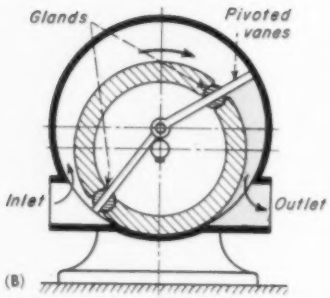
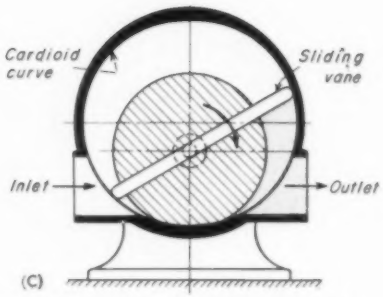


Fig. 1 — (A) Ramelli pump with spring-loaded vanes to insure contact with wall; vane ends rounded for line contact. (B) Two vanes pivot in



housing and are driven by eccentrically mounted disk; vanes slide in glands and are always radial to housing, thus providing surface contact.



(C) Housing with cardioid curve allows single vane to be used, because opposing points on housing in line with disk center are equidistant.

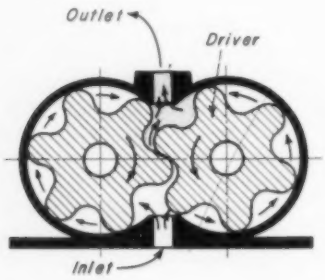


Fig. 5—Gear pump transports liquid between tooth spaces and housing wall. Circular tooth shape has only one tooth making contact and is more efficient than an involute shape which may enclose a pocket between two adjoining teeth, recirculating part of liquid. Helical teeth are also used.

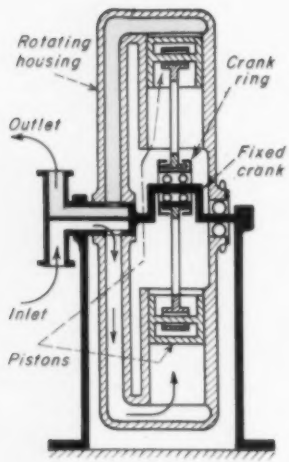


Fig. 8—Housing of Hele-Shaw-Beacham pump rotates round cranked shaft. Connecting rods attached to crank ring cause pistons to oscillate as housing rotates. No valves necessary since fixed hollow shaft, divided by wall, has suction and compression sides always in correct register with inlet and outlet ports.

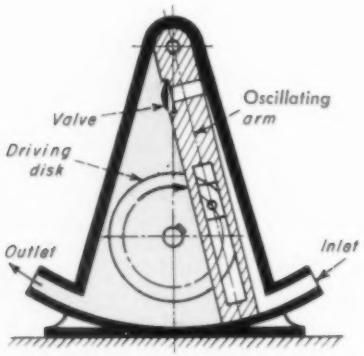


Fig. 9—Disk drives oscillating arm which acts as piston. Velocity of arm varies because of quick-return type mechanism. Liquid slowly sucked in and expelled during clockwise rotation of arm; return stroke transfers liquid rapidly.

Data based on material and sketches in AWF und VDMA Getrieblaetter, published by Ausschuss fuer Getriebe beim Ausschuss fuer Wirtschaftliche Fertigung, Leipzig, Germany.

Mechanisms

Polytechnic Institute of Brooklyn

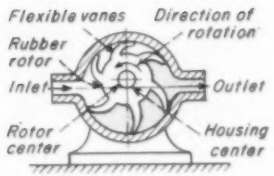


Fig. 2—Flexible vanes on eccentric rubber rotor displace liquid as in sliding-vane pumps. Instead of vanes sliding in and out, they bend against casing to pump.

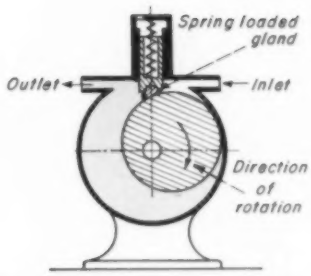


Fig. 3—Disk mounted eccentrically on drive shaft displaces liquid in continuous flow. Spring-loaded gland separates inlet from outlet except when disk is at top of stroke.

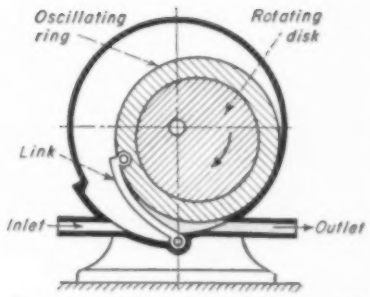


Fig. 4—Rotary compressor pump has link separating suction and compression sides. Link is hinged to ring which oscillates while driven by disk. Oscillating action pumps liquid in continuous flow.

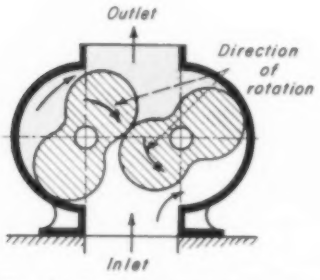


Fig. 6—Roots compressor uses two identical impellers with specially shaped teeth. Shafts connected by external gearing to insure constant contact between impellers.

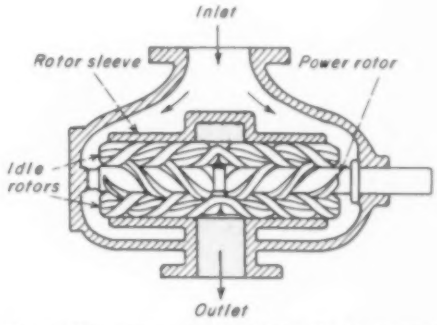


Fig. 7—Three-screw pump drives liquid between screw threads along axis of screws. Two idle rotors are driven by fluid pressure, not by metallic contact with power rotor.

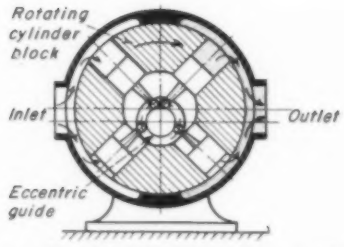


Fig. 10—Rotating cylinder block mounted concentrically in housing. Connecting-rod ends slide around eccentric guide as cylinders rotate and cause pistons to reciprocate. Housing divided into suction and compression compartments.

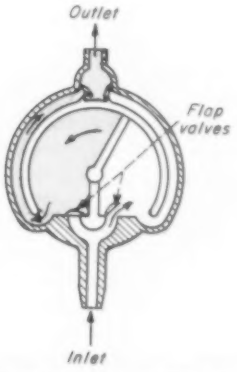
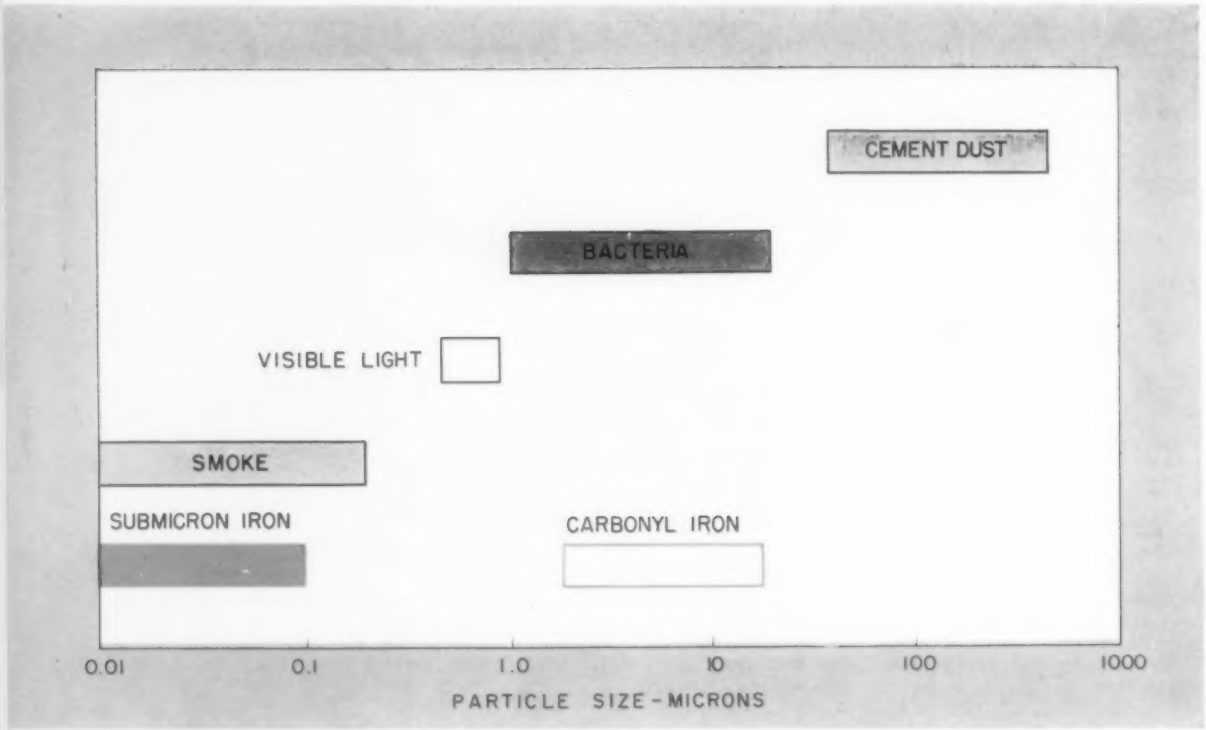


Fig. 11—Rotary-reciprocating pump usually operated manually to pump high-viscosity liquids such as oil.



Submicron Metal Powders

. . . make sintered parts as strong and dense as solid metal.

M. W. FREEMAN *and* JOHN H. L. WATSON, *Detroit, Mich.*

IRON, copper and nickel powders consisting of single-crystal particles in submicron range (0.01 to 0.05 micron) have been successfully alloyed with each other and united in actual chemical combination with nylon, rubbers and other elastomeric materials. Pressed and sintered structural parts of submicron pure iron (mainly test bars so far) have densities and tensile strengths much higher than for usual metal-powder parts.

At present, these powders are being produced by an electrolytic process on a pilot-plant scale. Particle shape and size are controllable and reproducible, within narrow limits of size distribution. The process produces dendritic, or tree-shaped, particles, of which the needle-type shapes are a stage in the growth and development of the basic metal crystal produced by the process.

Bearings of iron-copper and iron-nylon show no weight loss, eliminate oil contamination, operate without notable heat build-up and withstand considerably greater loads than other materials.

Iron crystals with the "needle" or nodular rod particle shape, possess coercive force in excess of 1500 cersteds, without the use of cobalt and nickel. Sintered compacts of iron with minimum amounts of copper give parts with electrical conductivity superior to that obtained with conventionally produced copper conductors.

In addition to fabrication by powder metal techniques, these submicron powders of iron, copper and nickel have been made into compacts by slip casting, plastic molding equipment, and roll-bonding.

All metal particles as small as those making up these crystallite powders are highly pyrophoric, igniting spontaneously at room temperature from oxygen in the atmosphere. By cooling to about −25 F, however, the powder can be safely handled. The self-igniting characteristic still prevails after compacting unless the parts are cooled in dry ice or kept in an atmosphere of commercial nitrogen. Pyrophoricity ends with sintering.

Colloidal copper crystals made by a process similar to the one used to make iron crystals also produces needles, rods and dendritic particles. This is the first production of dendritic copper crystals, so far as known.

Nickel powder plates for nickel-cadmium batteries were made from powder produced by the same elec-

trolytic process. Ordinarily these nickel plates are sintered at 1800 F; with submicron nickel powder, sintering can be accomplished at 1100 F and lower, resulting in greater surface area and greater energy output. This phenomenon is believed to arise from the higher diffusion rate for the crystallite powders, which in turn is caused by the much higher ratio of surface area to mass for these particles.

Ratio of Surface to Volume

Surface area per unit mass (or specific surface) ranges from about 16 to more than 20 sq m per gram. This means that any process which affects the bulk of the material but whose rate depends on the exposed surface area will be markedly increased as the particle size decreases. This has been shown in alloying, compacting, or co-reacting these submicron powders with non-metallic materials such as nylon, rubber, or other metals.

The finer the powder, the greater its chemical reactivity. This is an important factor in the physiochemical reaction between these iron crystallites and other metallic and non-metallic reacting matrices.

The microscopic dimensions of these particles makes for great differences in their properties when compared with larger particles of the same element. As a solid metal behaves very differently from the atoms of which it is composed, so these fine particles have characteristics which are very different from those of conventionally produced materials. At the same time, of course, compacts of the particles have properties which are a function of the particles of which the compacts are composed. Particles in many cases measure less than 50 atoms across, approaching in this case atomic dimensions. Many current theories of metals may require modification when applied to these fine particles.

To understand how these finely divided crystals exhibit greater chemical reactivity, they may be compared with small droplets. Small droplets of a liquid exhibit higher vapor pressure than bulk liquids in a manner related simply to the radius of curvature of the drop. Similarly, in a crystalline solid, the atoms at the corners have higher energies than those at the edges. These, in turn, have higher energies than those on the surfaces, which again have higher energies than those within the crystal. In the case of such fine particles as these crystals, with their large incidence of edges and corners, their contributions to the total energy will be considerable. In addition, the possibility of lattice deformation or displacement in the interior of such fine particles must be considered. These effects manifest themselves in two ways: 1) desirable properties in the individual fine particles; 2) superior characteristics of the particles en masse or when combined with other materials.

Usually in crystals, the atoms in the lattice have a relatively limited vibratory motion about more or less fixed centers, and these centers therefore remain fixed at characteristic regularly spaced positions which comprise the space lattice. This results in the remarkable symmetry of the crystals.

One of the outstanding characteristics of crystals is the force that exists between each atom and its neighbors. Therefore normal lattice spacing of any crystal will have specific value for that crystal. Iron is no exception. Now imagine that such extraordinary regularity of the space lattice has been deformed under controlled processing with consistent effect. Relatively large strain energy results, which under proper compacting conditions gives significantly greater physical properties.

Tests of tensile strength and ductility after sintering, for these iron crystals and for mixtures of them with aluminum, molybdenum, boron, and copper were carried out by Ferriss, Heck and Clark, of Stevens Institute of Technology. Table I shows a comparison of three of these mixtures with some commercially produced iron powders and iron-copper mixtures.

Effect of compacting pressure on green density for these fine iron crystals was determined by Stevens Institute, and by John Haller of Plymouth, Mich., as: At 30 tsi, 4.08 g/cc; at 40 tsi, 4.4 g/cc; at 50, 4.6 g/cc; and at 60 tsi, 4.78 g/cc.

Table II shows the practicability of hot-pressing and hot-coining formulations on parts made with the submicrons powder. Density is 6.76 g/cc, which is 103% of that of the straight wrought alloy itself. Hot-pressing was done in a carbon mold designed to make a ½-in. round specimen. A ceramic liner was employed to protect the material from carbon contamination. The compact pieces were hot-pressed at 1100 C for 3-min.

The same powder mixtures were also hot-coined. Tensile bars were pressed at 30 tsi; and heated to about 2100 F for 5 min in hydrogen, after which they were hot-coined in a 300-lb forced-fall drop hammer to the tensile bar shape. Some porosity and some oxidation occurred with this technique, which may account for the lower hardness values as compared with those specimens that were hot-pressed. These hot-pressed and hot-coined parts may be treated further with a special quenching step which is expected to increase hardness by one-third.

An xylol slurry of iron-copper powder mixture (4%)

Significance of Particle Characteristics In Powder Metallurgy

Strength and density of parts made by powder metallurgy depend largely on the diffusion process. With complete diffusion, a sintered compact would be as free of voids and strong as a solidified melt. It is the relation between volume, surface area and intimacy of contact that influences the extent of diffusion.

With metal powders of the size commonly used, the highest practical compacting pressure and sintering temperatures still leave a large proportion of voids where diffusion has not taken place. But by reducing the size of the particle—particularly when these particles are single, integral crystals—the same conditions produce more complete diffusion and a sintered compact of greater strength and density.

One of the most significant things about these submicron powders is that they have such strong interparticle bond and can be made so fine that sintered compacts have strength and density comparable to solid metal. Particles are as fine as in tobacco smoke—some only 50 atoms across; it would take a billion of them to equal the volume of a typical metal-powder particle. In addition, with these submicron particles, diffusion or chemical union can take place between metal and organic materials.

Table I—Comparison of Density, Strength and Elongation

	Sintered density, gm/cc	Tensile strength, psi	Elongation, % in 1 in.
Submicron Powder			
Pure Iron	7.27	42,200	29
Iron with 5% copper	7.22	80,000	4
Iron with 15% copper	7.89	116,000	3
Commercial Powder			
Plastic metals, electrolytic	6.48	18,800	10
Plastic metals, sponge iron	6.36	20,800	5
Swedish sponge iron	6.19	15,600	7
Buel electrolytic	6.43	17,700	11
Metals Refining iron	5.80	11,700	2
Electrolytic iron, 0.6% C, 2% Cu	7.0	65,000	5
Electrolytic iron, 7% Cu	....	75,000	..

was briquetted at 20 tsi into a flanged cylinder measuring 0.432 OD x 0.305 ID x 0.731 flange OD. After 3 hr. of sintering at 2000 F, a density of 7.34 g/cc was reported. Shrinkage of the body was 15% and that of the flange was 16.75%. This indicates that a part of complex shape made of this powder may have uniform shrinkage along its different thicknesses.

Further Developments Coming

It is the opinion of the authors that methods of putting these new single crystals of metal together will have to be further developed. When this is done, the physical properties of the compacted and alloyed materials should be considerably increased.

To quote from the Stevens Institute report:

"The process of slip casting utilizes fine particles as a raw material and can be used to produce shapes not ordinarily considered for powder metallurgy. Slip casting also utilizes particle size as a controlled variable and high sinter-ability as a necessity. Composition gradients in nuclear fuel elements are possible by this technique.

In roll bonding, the excellent green bonding characteristics of the Freeman powders lends itself to this technique for iron and alloy mixtures. A viscous, resin bonder may be used so that the material need only be cured, not sintered.

Fabrication of parts by hot pressing or hot coining is quite possible. The unusual fineness of the powders is admirably suited for establishing structures analogous to the sintered aluminum powder development.

Iron-aluminum alloys offer very promising potential. Their oxidation resistance is excellent; they are not critical elements; their melting point would indicate that dispersed phase hardening can raise the useful temperature to 1400 or 1500 F. It has been indicated that additions of 5, 10 or 20% of these ultrafine iron particles to commercial reduced or electrolytic grades of iron powder will greatly increase sintered density and strength."

Table II—Hot Pressed and Hot Coined Submicron Powder Mixtures
Solid metal density, 6.56 g/cc.

	Hot Pressed		Hot coined	
	Density, g/cc	Hardness, (R_c)	Density, g/cc	Hardness, (R_c)
Mixture 5	5.61	19–23	5.84	16–24
Mixture 9	5.72	21–26	6.24	15–20
Mixture 11	6.76	26–28	6.23	17–24

At Vickers, Inc., a bearing part was prepared from an iron-copper mixture and tested on a McMillan wearing machine. The testing oil, Oronite 8515, is a synthetic hydraulic fluid with poor lubricity. The bearing used for comparison in these tests seized after 564,000 revolutions, and lost about 1% in weight. There was a tendency for small particles to chip off; the coefficient of friction after 2000 revolutions was 0.152, and the oil became very dark, thick and hot.

Under the same test conditions, the bearing made from submicron powder showed no loss in weight after 722,870 revolutions, disclosed no observable wear on the surface, and the coefficient of friction after 10,000 cycles was only 0.068. The oil was as clear as when the test started, and at the end of the test its temperature was only 86 F with a room temperature of 77 F. The bearing surface remained untouched by the test.

A trunion bearing made from nylon and the new molecular iron powder was compacted by the Jim Robbins Co. using an injection molding process, employing 50,000 to 60,000 psi pressure. After the molding was accomplished, the trunion bearing was readily freed of stresses by the usual means. The material proved highly resistive to cold flow after the initial setup and could withstand excessive loadup pressures.

The Ford Motor Co. has experimented with bearing parts made of a mixture of nylon and molecular iron when used as a leaf spring insert, the life expectancy of the insert exceeded that of the spring itself. To quote from the Ford report:

"Some of the inserts have been subjected to more than 300,000 cycles with no perceptible wear and without noise. The coefficient of friction appears to be favorable for such an application and the surface of the steel underneath the insert appears to be cleaner than with many of the other insert materials previously produced and tested."

Another investigation now under way at Ford is presently developing combinations of submicron iron powder with GR-S rubber, butyl rubber and other elastomeric compositions.

EDITOR'S NOTE. For a review of the field for commercial metal powder materials see "Powder Metal Process and Part Design," Design Digest, Mid-October 1955 page D14; effect of size, shape, tolerances and properties on selection of the process; properties of powder metal particles.

How Much CROWN Does A Pulley Need?

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What is crown? How do belts behave on misaligned pulleys? What's the relationship between crown, belt tension and pulley misalignment? How about stress distribution in belts? Here are answers to these questions and tests which check analytical procedure.

Crown is added to a pulley to keep flat belts from running off when the pulley is misaligned. But . . . the amount of crown to add has never been standardized, and recommendations vary with the authority. In fact, no published recommendations take into account the combined effect of misalignment and center distance, belt tension and material, pulley width and diameter. By considering the elastic behavior of the belt, the effect of crown on belt stresses, and the stress distribution across belt width, a systematic method has been developed to determine the proper height of crown. The method gives results in close agreement with recent tests conducted at Ohio State University.

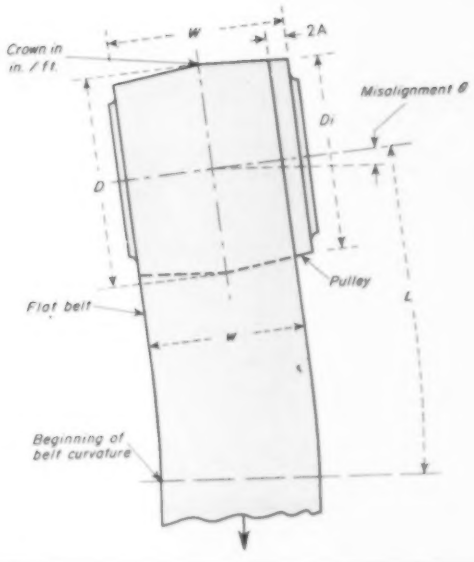
Definition of Crown

Although several accepted methods specify the height of crown, it is best specified in terms of the difference between maximum and minimum diameters, per foot of total pulley face:

$$c = \frac{12\,(D - D_i)}{W} \qquad (1)$$

where c is the crown, in./ft, and W is the width of the pulley face, in. For a pulley with $c = 0.1$ in./ft, $D = 12$ in., and $W = 24$ in., dia D_i will be:

$$D_i = 12 - \frac{(0.1)\,(24)}{12} = 11.8 \text{ in.}$$



Symbols

- A — side clearance between belt and pulley when belt is centered, in. $A = \frac{1}{2}\,(W-w)$
- c — crown, in./ft.
- D — diameter of pulley, in.
- e — eccentricity of resultant belt pull equal to the distance between the resultant belt pull and center line of belt, in.
- E — belt modulus of elasticity, lb/in.
- L — Length of belt subject to curvature, in.
- S — average unit stress in belt, lb/in.
- T — belt tension, lb
- w — belt width, in.
- W — pulley width, in.
- θ — allowable misalignment, radians

and the height of the crown h will be:

$$h = \frac{12 - 11.8}{2} = 0.1 \text{ in.}$$

Belt Behavior on a Pulley

The general concept that a belt always travels to the high side of a pulley is not true. Actually, a belt tends to travel toward the high diameter or toward the side having the shortest center distance from the opposing pulley, depending on the particular case.

When a piece of string is wound onto a pulley, Fig. 1 (A), a lead angle θ is required to form a single layer of string on the drum. Direction of spiral is toward the side with which the string forms an angle of less than 90° with the axis of rotation.

To wind the string continuously at one point, one layer on top of another, and still have the string approach the drum at some angle other than the perpendicular, an idler or other device is necessary to change the angle of approach, as shown in (B). This also

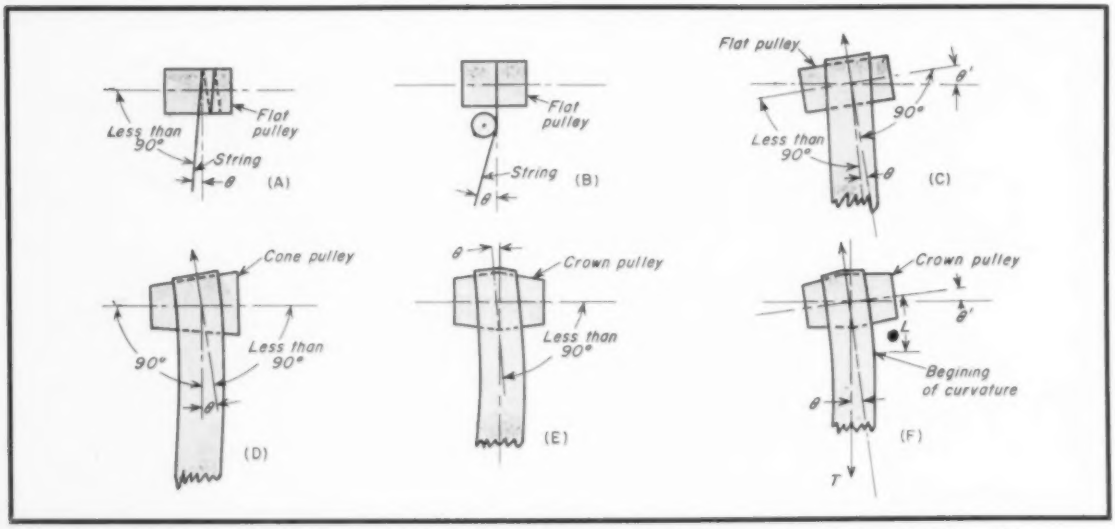


Fig. 1—Relationships between the angle of approach θ, angle of misalignment θ', and type of pulley. Belt will walk off to the left or "low" side of the pulley in (C), but to the right or "high" side in (D).

holds true for a flat belt or if the belt passes around the pulley instead of winding on it.

With a misaligned pulley, as in (C), the belt may curve slightly as it approaches the pulley, but the angle of approach at the point of contact will be less than 90° (or an approach misalignment of θ). The belt will "walk" off the pulley to the left or "low" side.

A belt running on a cone pulley, as in (D), with the same initial conditions, will curve to approach the pulley with a larger angle of misalignment θ than in (C). The belt will walk, in this case, to the right or high side.

The reason for the belt curving on the cone pulley is that the belt is stretched more on the large diameter than on the small-diameter side. The belt is therefore more highly stressed on the large-diameter side, the amount of the stress distortion being a function of the taper of the crown, stiffness of the belt, and diameter of the pulley; the amount of curvature is a function of the stiffness, length, width, and tension on the belt.

When a flat belt is off center on a properly aligned crown pulley, it also curves on the approach and return sides of the pulley as in (E). The angle of approach is less than 90° on the right side, so the belt tends to spiral in that direction just as the piece of string in (A) would do. This corresponds to the popular concept that the belt tends to walk toward the high diameter of the pulley, thus to center itself.

The belt will gradually lose its curvature as it gets closer to the center of the pulley. Thus, for a crown pulley, the centering force is proportional to the displacement from center.

For a belt to run continuously on the misaligned crown pulley shown in (F), the angle of misalignment must not be greater than the angle of curvature. Therefore the maximum allowable misalignment in a crown pulley is equal to the angle of curvature θ. At some distance away from the pulley, the belt centerline is approximately the same as it would have been had the shaft been aligned correctly and the belt at the pulley been running on center. In other words, a crown tends to keep the main body of the belt running on the true center of the pulley or conveyor roll even though the belt may be off center when passing over the pulleys.

Equations for Allowable Misalignment

An eccentrically loaded belt is analogous to an eccentrically loaded beam in tension. The equation for the misalignment that will cause a belt to run off a pulley was derived from material in "Airplane Structures", Niles and Newell, John Wiley & Sons, Inc:

$$\theta = (e/j) \tanh (L/j) \tag{2}$$

$$\text{where } j = \sqrt{\frac{E\,w^3}{12\,T}} \tag{3}$$

By developing equations for e and L, Eq (2) can be simplified. The value of eccentricity e varies with the type of crown employed on the pulleys. In the past, it was common practice to use on transmission pulleys a radius crown more spherical than conical. Because of the higher cost, the radius crown was replaced by one having a straight taper coming to a peak at the center. For this type, eccentricity is approximately:

$$e = \frac{c\,E\,A}{24\,D\,T}\left(w^2 - \frac{4}{3}A^2\right) \tag{4}$$

Eq (4) is only valid when full belt width contacts the pulley. With excessive crown or too little tension, a high-modulus belt will contact only at the middle. The theoretical minimum tension for which Eq (4) is valid is

$$T_{min} = \frac{c\,E}{24\,D}\left(w^2 + 4\,w\,A - 4A^2\right) \tag{5}$$

An important assumption involved in deriving Eqs (2) to (5) is that the belt is wholly elastic and not subject to permanent stretch. As belts do stretch permanently, the equations should be modified in ac-

cordance with the degree and effect of permanent stretch. Fig. 2 shows the change in stress pattern across the width of a typical belt. Stresses in a new belt are shown in (A) and (B). Most of the stretch occurs in the zones of highest stress, thus reducing the peak stress in the center when the belt is running over the pulley. This ultimately results in new stress patterns (C) and (D), in which the peak stress in the center of the belt is estimated to be half its former value above the average stress, the peak stresses shifting to the edges of the belt when the belt is between the pulleys.

It is also assumed that the stress pattern does not extend beyond the points of actual contact of the belt with the pulley. This assumption is reasonably correct with belts of low modulus such as duck and cotton-cord belts, but is undoubtedly in error with steel-cable belts, which have a high modulus. Also the stress reduction shown in Fig. 2 is higher with small arcs of contact or small-diameter pulleys.

Relationship Between Belt Length and Misalignment

It can be noted from Eq (2) that the allowable misalignment increases as the length of belt subject to curvature increases. In a transmission-belt drive having a 1:1 ratio, and with both pulleys crowned, the belt length subject to curvature is simply half the center distance of the drive. If only one of the pulleys is crowned, the length subject to curvature is the full center distance.

On a conveyor having crowned pulleys on all the slack-side locations, the length would be half the distance to the next crowned pulley, or the full distance to the next idler or uncrowned pulley.

For all other conditions, a fairly accurate approximation can be used. In Eq (2), as L approaches infinity, the hyperbolic tangent of L/j approaches unity; however, the approach toward unity is rather rapid, and a relatively short belt will give a value of θ almost as high as will a very long belt. The value for L that will give 99% of the allowable misalignment of a belt infinitely long is:

$$L = 0.72\, w\, \sqrt{E/S} \tag{6}$$

For 80% effectiveness, value for L is

$$L = 0.315\, w\, \sqrt{E/S} \tag{7}$$

Values of L/w for different types of belts and for 50, 80 and 99% effectiveness are listed in Table I. To obtain L, multiply the ratio L/w by the belt width. This value of L from the table or from Eqs (6) or (7) can then be directly substituted in Eq (2).

With further assumptions, it is possible to simplify still further the equation for allowable misalignment. By assuming that side clearance A is small in comparison with belt width, Eq (4) becomes:

$$e = \frac{c\, E\, A\, w^2}{24\, D\, T} \tag{8}$$

And if there is sufficient belt length to make L/j substantially equal to unity, then Eq (2) reduces to:

$$\theta = \frac{c\, A}{6.9\, D} \sqrt{\frac{E\, w}{T}} \tag{9}$$

Certain conclusions can now be made, based on Eq (9):

1. **Allowable misalignment is directly influenced by the amount of crown,** up to some point of maximum effectiveness which varies according to the type of belt and applied tension.

2. **Pulleys should be considerably wider than belts.** In other words, clearance A should be as large as possible. A crown is only effective if the belt is allowed to move off center. If a belt can be kept in a fixed position on its pulleys, a crown will be of no assistance.

3. **Reducing pulley diameter increases allowable misalignment.** But decreasing diameter also increases peak stress.

4. **Decreasing belt tension increases allowable misalignment,** until a certain low tension is reached below which there is little or no increase in effectiveness.

5. **Belt speed does not influence effectiveness of a crown,** other than perhaps the effect of centrifugal

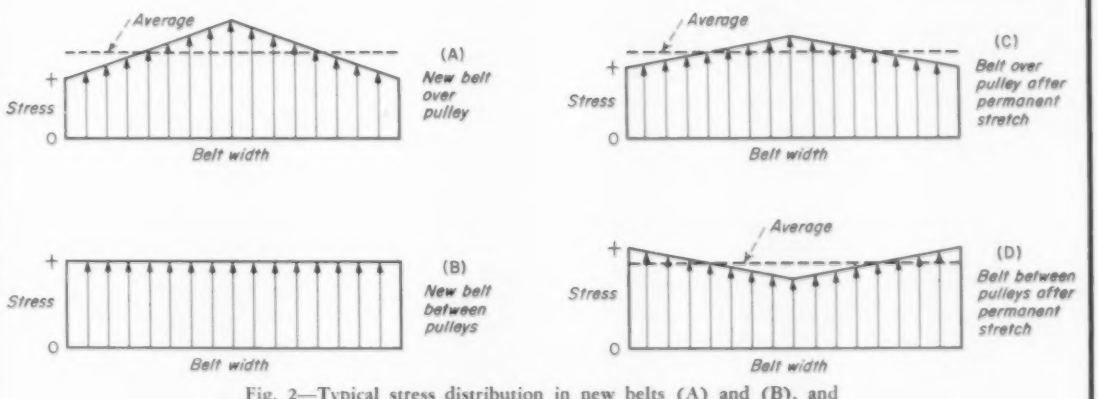


Fig. 2—Typical stress distribution in new belts (A) and (B), and in belts that have permanently stretched after operation, (C) and (D).

TABLE I—LENGTHS OF BELT SUBJECTED TO CURVATURE

Belt Type These values are for one supplier. Each supplier has own belt size designation, not necessarily with these specific properties.	Unit Stress S lb/in.	Modulus of Elasticity E, lb/in.	Ratio L/w		
			99% θ_{max}	80% θ_{max}	50% θ_{max}
10 ply 42 oz duck	485	30,000	5.7	2.5	1.25
9 ply 48 oz duck	522	27,000	5.2	2.2	1.1
10 ply heavy rayon	580	63,300	7.5	3.3	1.6
Cotton cord A	435	38,000	6.7	3.0	1.5
B	570	125,000	10.7	4.7	2.3
Steel Cable C	530	268,000	16.2	7.2	3.6
D	660	335,000	16.2	7.2	3.6
E	800	402,000	16.2	7.2	3.6
F	1070	536,000	16.2	7.2	3.6
G	1330	670,000	16.2	7.2	3.6
H	2250	1,090,000	16.2	7.2	3.6

tension, which would tend to reduce crown effectiveness. In general, at least for conveyors, speed influences rate of response only.

6. **High-modulus belts will operate with more misalignment than low-modulus belts,** providing the required minimum tension is maintained and the belt can stand the peak stress that the crown introduces. High-modulus belts, however, are excessively stressed by high crown. Even so, crown is effective on steel-cable belts.

7. **Effect of belt width on misalignment is negligible** because belts are normally rated on an allowable tension per inch of width, and the ratio of w/T will remain constant for a given type of belt regardless of width. Thus for a given crown, a wide belt will usually have the same response as a narrow belt. A crown, however, introduces more peak stress in wide belts than in narrow belts.

Effect of Crown on Peak Belt Stress

Because the effectiveness of a crown results from distortion of the stress pattern in a belt, it follows that a crown must increase the peak stresses in a belt. When a belt with a standard crown fully contacts a pulley, and the belt has shifted the full amount of the side clearance, the increase in peak stress over average stress is:

$$\Delta S = \frac{c\,E}{6\,D}\left(\frac{w}{16} + \frac{A^2}{w}\right) \qquad (10)$$

Thus the increase in belt stress is directly proportional to the amount of crown. The increase in low-modulus belts, however, may be as low as half the value obtained from Eq (10) because the equation was derived on the assumption that no permanent stretch occurs in the belt. A standard crown of 0.10 in./ft can be used safely on all belts whether of high-modulus or low-modulus materials.

TABLE II—COMPARISON BETWEEN TEST RESULTS AND COMPUTED VALUES

Belt tension, lb	Allowable Misalignment, deg		Ratio of computed/tests
	Computed values	Test results	
85	5.14	3.1	0.60
170	3.68	2.2	0.60
225	3.0	1.9	0.63

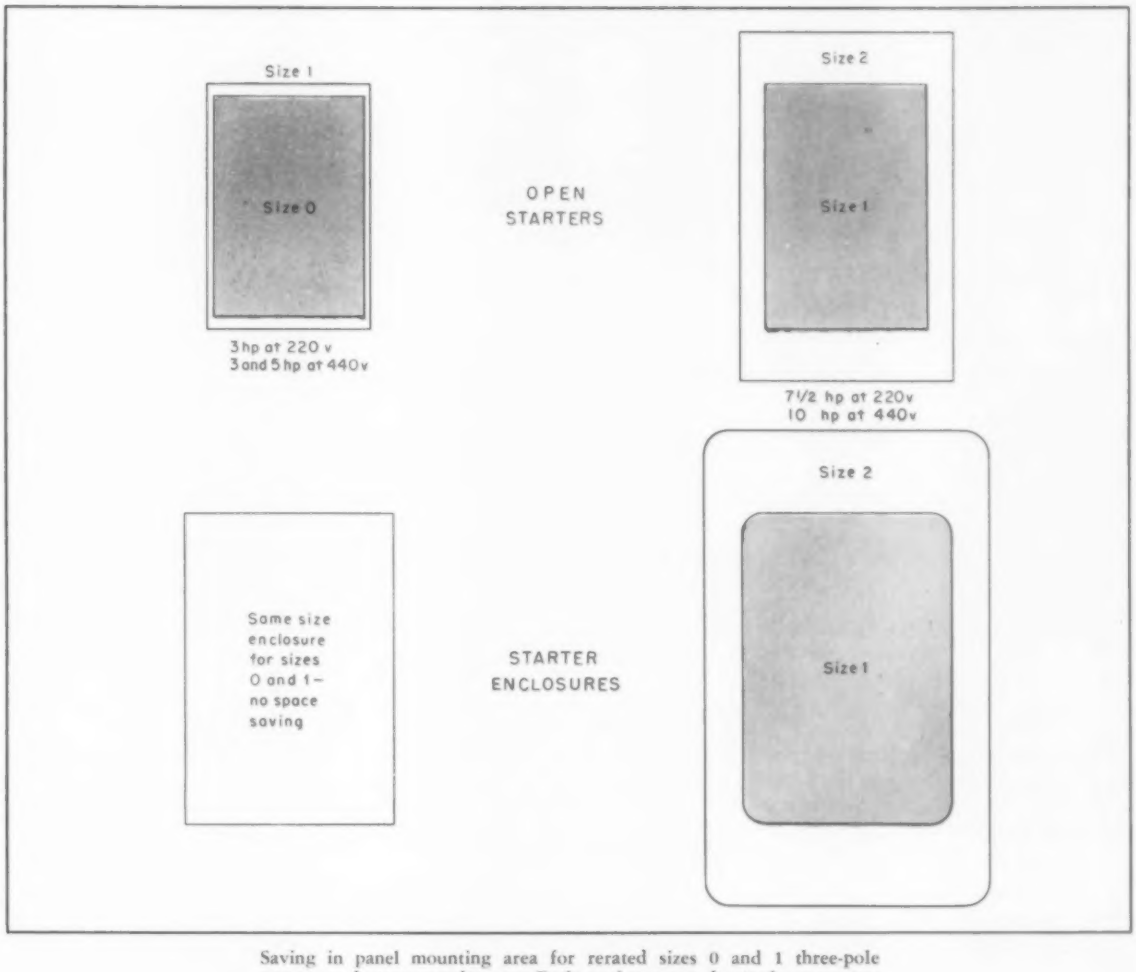
Comparison of Equations with Test Results

Because of the assumptions in the above analysis, Eq (2), or its more simplified version, (Eq (9), may give higher values for allowable misalignment than can be safely used.

Some indication as to how much higher the theoretical values are can be obtained from the tests conducted on crown pulleys by Prof. C. A. Norman, Ohio State University, and reported in the University's Engineering Bulletin No. 135. Table II lists values of allowable misalignment obtained from Test No. 4 using a 3-in.-wide by 16-ft-long cotton-duck belt running on a 8¾-in.-dia pulley and driving a 22-in.-dia pulley. Both pulleys had a crown of 0.125 in./ft and a side clearance of 1.5 in. The table also lists computed values using Eq (9). Note that the computed values permit a maximum misalignment that is approximately 60% higher than test results.

A "compensating" factor of 0.6 can be arbitrarily assigned to the equations to reduce the values in accordance to the test results for duck belts. The factor, however, may be different for each type of belt and should be used only if the complete test conditions are known.

The test data did verify the relationship between the allowable misalignment, belt tension and effective belt length. When the tests are replotted and projected to zero, the linear relationship between misalignment and crown is also verified. The proportional relationship of side clearance to misalignment is brought out by comparing the values of various belts run with 1.5-in. and 0.5-in. side clearance. But above all, both the theoretical analysis and the test results indicate the importance of providing a crown on pulleys, regardless of type or operating conditions. ●



Saving in panel mounting area for rerated sizes 0 and 1 three-pole starters and starter enclosures. Ratings shown are for 3-phase motors.

New NEMA Standards for Motor Starters

Reduce Cost and Space

Three-year study leads to adoption of increased current rating and reduced size for a-c motors from 1-10 hp.

J. R. McDERMOTT, *Associate Editor, Product Engineering*

NEMA standards for starters used with 1 to 200-hp motors have been unchanged since 1937. Modern equipment design trends have created pressure for reevaluation of motor starters in three areas: First, for each motor applied, hp ratings are increasing. Second, whereas formerly one or two large motors were used and on a machine with mechanical power takeoffs such as belts, drives, and transmissions to perform operating functions in several locations in the equipment, now more and more individual motors in the 1 to 10-hp range are applied to give independent control of nonconnected operating functions. Third, as a result of the increased numbers of motors being used per machine, the increasing space occupied by the controls has become a critical factor which in turn demanded smaller starters.

NEMA RERATING OF SIZES 0 AND 1 STARTERS

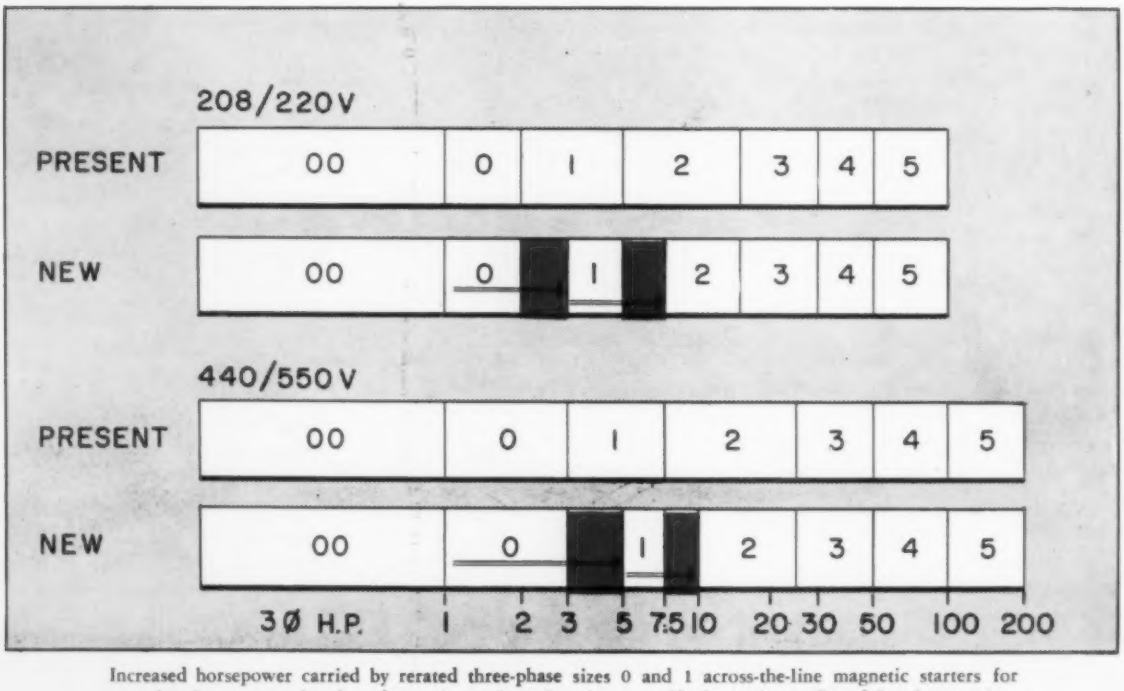
NEMA Starter Sizes		Motor Horsepower Ratings						Enclosed Current Rating, amp
		Single-Phase			3-Phase			
		115 v	230 v	440/550 v	110 v	220 v	440/550 v	
0	OLD	1	1½	2	1½	2	3	13.5
	NEW	1	2	3	2	3	5	18
1	OLD	1½	3	5	3	5	7½	22.5
	NEW	2	3	5	3	7½	10	27

These forces have resulted in an industry-wide re-evaluation which, after three years, has resulted in the uprating of the NEMA size 0 and 1 used in the 1 to 10-hp class. Although only two sizes have been uprated more than three-quarters of the motors used today fall within this range. The old and new ratings of this revision of NEMA Standards for Industrial Control, part 21, paragraphs 1C 1-21.01, 21.02, and 21.03, are shown in Table I. Whereas 8-hr current ratings for open starters were formerly included, they have now been dropped and only the enclosed-starter continuous ratings (90% or open) are now used.

This uprating has been made possible by the continued universal improvement in design and materials which have occurred since the previous ratings were established 20 years ago. These improvements have been particularly significant in the areas of hot and cold molded contact housing and support materials, in contact material and design, in reduction in contact arcing, and in newer methods used to close higher currents and carry them continuously without freezing.

Starters affected by the change are of the across-the-line, full-voltage type used for starting duty only. Starters used for plugging or jogging duty retain the old ratings. The relationship of the rerated starters to the full line of NEMA starter ratings for fractional hp to 200 hp are shown in Fig. 1 for 220 and 440-v three-phase starters. The areas of uprating are indicated in color.

Cost savings, based on list prices of three-pole open starters, can range from 5%, where size 0 starters now replace size 1, to as high as 43%, where size 1 replaces size 2. Approximate savings in space are shown in the diagram.



Increased horsepower carried by rerated three-phase sizes 0 and 1 across-the-line magnetic starters for non-plugging or non-jogging duty. Areas in color show specific hp ratings affected by the rerating.

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Here's What Happened...

. . . on-the-spot evaluation of papers and discussion

. . . a survey of all exhibits

. . . by the Editors of Product Engineering

Developments
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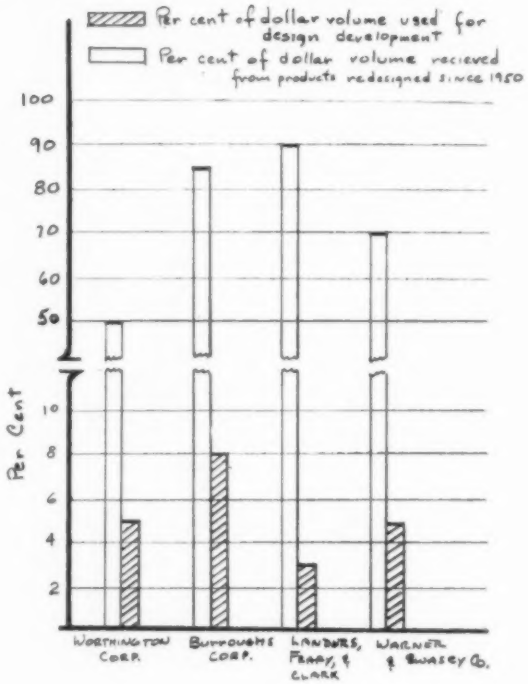
50 to 90% of Industry's Income is from New Designs...

These figures are indicative of the design activities in many major U S product industries. Since 1950, based on product lines, panel members at the opening session of the ASME Design Engineering Conference on "Procedures in Developing New Designs" reported: George Habach, vice-president of Engineering, Worthington Corp., "More than 50% of the company's income comes from new product lines or products which incorporate major design improvements in this period." T. M. Butler, director of engineering, Burroughs Corp., said that his company's figure is 85%, and Myron S. Curtis, engineering vice-president of the Warner & Swasey Co., said 70%. William J. Russell, vice-president, Engineering, Landers, Frary & Clark, manufacturers of consumer products, cited a figure of 90% of which 15% consists of completely new products. (See chart at right.)

How much does each company pour back into research? In terms of the company's dollar volume, answers were something like this: Worthington, 5-7%; Burroughs, 8%; Warner & Swasey, 4-5%; and Landers, Frary & Clark, 2½-3%. (See chart at right).



No Planned Obsolescence...

All panel members stressed that there is no "planned obsolescence" in their product lines. But there is a continual search for improved designs. Designs presently on the drawing boards or in the planning stages may not see the light of day for one to 10 years. Mr. Russell indicated two dangers in any new design, but most prevalent in the appliance field: (1) Being caught short by unexpected improvements; and (2) Being ahead of the customer or consumer with a new product.

New Product Ideas...

Many new design ideas are developed through market research, from users or customers and from projected future needs of customers. Sales and service engineers' reports are also carefully screened. Worthington relies heavily on sales engineers to keep engineering and management informed of changes and competition. Warner & Swasey have a department which checks operation of, and users' comments on their machines. Appliance manufacturers rely on service stations where their products are checked or repaired; Burroughs uses field-research men to pass on customer comments, suggestions or gripes. But all must be analyzed from these standpoints: will the product be able to perform some worthwhile function; is it interesting; will it make life easier; will it sell to the public?

Mr. Curtis conceded that Warner & Swasey always ran into the difficulty of almost a complete cessation of machine-tool buying after each war, and that when it decided to diversify, it made market analyses, and used direct mail for ideas. The latter method resulted in literally thousands of ideas, many ludicrous, but many sound and worth investigating. As a result, the company entered the fields of earth-moving and textile machinery.

Mr. Russell said that about 40-million housewives and their husbands are an excellent source for complaints—and for ideas for both new products and improvements to old products. "With service stations all over the country for repairing these appliances, in addition to distributors and salesmen, we can gage the customer's reaction to a product."

The value of the "brainstorming" technique for suggesting ideas for new product also came up for discussion. Mr. Habach said that he found the system very helpful, but most of all he found that it was a very effective way of getting rid of negative ideas. Ideas are not condemned without getting a hearing.

Creative Thinking...

Regardless of product, appearance design plays a large part in the success of sales. Robert Hose, Henry Dreyfuss Associates, and Milton Immermann of Walter Dorwin Teague Associates—the other panel members—indicated that the product must give the visual impression that it will operate. Appliances are sold on the basis of visual impression; larger equipment should have the right look for the job it must perform, Mr. Hose indicated.

However, these points should not nullify creative thinking. Appearance and design of future items need not match those of present-day designs. The product or the problem should be defined, then the product designed to meet the function. Here the industrial designer can supply ideas to the design engineer. As Mr. Hose pointed out, the designer should be equally concerned with machine tool or appliance performance, and the comfort of the operator or user when using the equipment. Mr. Immermann emphasized that a crash program to meet crises caused by competition introducing a new design invariably produced inferior results and that creative planning could minimize such action.

Leadtimes: 1 to 10 years...

Leadtime from product conception to sale varies, depending on the product field. Mr. Russell reported that in the appliance field it is possible to get a product to the consumer in six months. Normal leadtime is about one year. Machine tools and heavy equipment, on the other hand, may take from two to six years. Mr. Butler of Burroughs cited one design that took ten years from conception to finished model. As much as eight years was spent testing six different typing methods before one was considered acceptable.

How Many Prototypes?...

Many models never see the light of day. Mr. Russell reported that five to 20 models and five to six style designs may be made of an appliance before one is produced Mr. Curtis said that for every finished machine-tool element, five models might be made. Approximately 15% of all pump models are discarded; of those that remain, 85% are reworked before they can be marketed. Of all designs started in Burroughs, only about 20% reach the final-model stage, according to Mr. Butler.

Motor Rerating Aids the Designer

Advances in materials, design technique and manufacturing practices, and to meet today's industrial application conditions are the reasons given by Earl C. Barnes, assistant chief engineer, Reliance Electric & Engineering Co., for the rerating program for a-c and d-c integral-horsepower motors.

Mr. Barnes pointed out that specific increases in horsepower rating per frame size are in the order of 30 to 100%. This has been coupled with improved operating characteristics.

Weight reductions range from 15 to 40%. Most of the saving is in inactive portions of the motors such as the frame, not in working components such as cores, windings, shafts or bearings.

A-c frame sizes were reduced from nine to eight. D-c motor ratings were reduced from over 500 to 150. These 150 ratings cover the application engineer's needs for all d-c motor applications.

Enclosure protection far exceeds old standards. The drip-proof enclosure for today's motor is better than the old splash-proof enclosure. Corrosion-resistant materials in motor fans and structural parts are common. Also, design of bearing housings, frames, conduit outlets, prevent motor damage from moisture and foreign parts.

Psychological and physiological effects of noise received considerable attention. Mr. Barnes indicated that noise is often directly attributable to the method of mounting motors on driven machines or structures.

Mr. Barnes cited several examples in which new motors have been successfully applied. One was in a textile plant where the new motor was mounted under the spinning frame. Previously, the motor was mounted behind the frame, taking up valuable space. Also, the motor was larger to provide necessary horsepower. In a new mill installation, the space saving would cut building space cost.

Other papers presented at Electrical Sessions of the Conference include: Static Switching Devices by Robert Mathias, Carnegie Institute of Technology; Numerical Control for Machinery by Claude D. Coffin Warner & Swasey Co.; and Designing Machine Tools for Automatic Controls by C. B. Sung, Bendix Aviation Corp.

Ti, Be, Mo Alloys Coming...

New alloys of titanium, nearly through development and soon commercially available, show high promise, according to Charles Simcoe Battelle Memorial Institute. One of the most promising is Ti-6Al-4V, apparently the first all-purpose titanium alloy to be developed. It is superior for forging, may be the answer as a fastener material. In addition, it can be rolled into sheet with superior strength and moderate heat-treatment response. Solution heat-treated and aged, ultimate tensile strength will be upward of 170,000 psi and yield strength about 160,000 psi at room temperature.

Mr. Simcoe believes that by the end of the year from 30 to 36 million lb of titanium will be available. However, companies should not plan to use large quantities (several hundred thousand pounds) immediately for product design.

A structural material for aircraft that shows promise is beryllium. Current major drawback: brittleness at room temperature, and cost—about $100/lb for powder.

Major work has been done with molybdenum alloys. However, room temperature ductility and oxidation at elevated temperatures are still a problem. Better oxidation resistance may come from protective coatings. Best to date: ceramics. Even with a coating, Mr. Simcoe said, 100% protection is necessary, as the smallest pinhole can cause failure because of the volatile nature of the oxide.

Edward Smoke, Rutgers School of Ceramics, pointed out many new developments in the fields of ceramics

Notes from the DESIGN CONFERENCE

and refractories that show future industrial promise.

A major advance in high-temperature refractory service is flame spraying ceramic coatings on practically any metal. They are also hard and abrasion resistant. New types include: electrically fused magnesite base refractory for the steel industry; and a tar bonded dolomite refractory for oxygen converter process of steelmaking.

Mr. Smoke reported that some newer high temperature refractory castables are being made from fused Al_2O_3 bubbles or hollow spheres and give good heat insulation to 3300 F. A high purity alumina castable, dense grained rather than of bubble structure has a service temperature to 3400 Fahrenheit.

Cermets show increasing strength with temperature, improved oxidation resistance and thermal endurance; improved corrosion resistance in contact with molten metals. For jet engine application, Mr. Smoke cited a cermet based on chromium-molybdenum boride that at 1800 F has better oxidation resistance and strength than titanium carbide. Thermal shock resistance is about the same.

Other papers presented at the Materials Sessions of the ASME Design Engineering Conference includes: Plastics and Rubbers by Wyman Goss, General Electric Co.; and Coatings and Finishes by H. J. Reindl, General Motors Corp. Mr. Goss' paper was presented by Alden P. Landall, General Electric Co.

DESIGNER: Key to Automated Production

Increased development of automated production and assembly lines requires a fusing of the duties of product design, materials handling and tool engineering personnel according to Kurt O. Tech, vice-president Engrg., The Cross Co. Any product may be completely produced and assembled automatically, but cost becomes prohibitive unless materials-handling and tooling problems are solved during design. A thorough knowledge of limitations of automatic equipment is essential if continued progress is to be made.

Complete automation is extremely expensive, rarely considered. Great economies can be achieved by partial automation; leaving the most difficult operations for manual assembly. Initial auto assembly lines were 25% automated, and as operations were simplified the percentage was increased. Operation 75% of the time is good efficiency. But the 25% downtime is being reduced.

The need for an understanding of the equipment available for automated assembly was stressed by Floyd E. Smith, president, Perry Equipment & Engrg. Co. Feeders, Mr. Smith pointed out, should not be expected to sort, gage, space or inspect parts. These operations must be performed by additional equipment fed by hopper feeding devices. Part design should also take into account the limitations of hopper-feeding devices to avoid excessive tooling expenses. Many parts cannot be fed in the desired position unless the design incorporates some feature that the feeder mechanism can distinguish.

William C. Allen, director, Mfg. & Equipt. Engrg., Westinghouse Electric Corp., stated that Westinghouse does not consider automation unless a savings of at least 20% could be realized and are working for at least a 33⅓% savings figure. The economy of automated assembly Mr. Allen stated, is based to a large degree on reduction of handling of the part away from the line. Ideally costwise, production equipment should be tied to assembly equipment. Parts that are double handled (externally moved from production to assembly equipment by a separate operation), drastically reduce possible savings by automation.

Other papers at Mechanical Sessions of the Conference include: New Developments in Design and Application of Gearing by Darle W. Dudley, advanced design engineer, Gear Engineering, General Electric Co.; and New Developments in Design and Application of Cams by Harold A. Rothbart, professor, Dept. of Mechanical Engrg., City College of N. Y.

The
Machine Design Division
of The American
Society of
Mechanical Engineers
by action of its Executive Committee is honored
to present this Citation of achievement to
George F. Nordenson
for his efforts in establishing our
Annual Design Engineering Conferences.
His foresight to appreciate the benefits to
be gained by holding a professional conference
for design engineers in conjunction with a
major annual exhibition, his perseverance in
obtaining the support of the Machine Design Division
and his skill in programming the technical
sessions deserves this recognition. The
Design Engineering Conference provides a
national forum to specifically serve the pro-
fessional needs of the design engineer.

Editor of *Product Engineering* honored for his efforts in establishing ASME Design Engineering Conferences.

Miniaturization Hits...

Trend to miniaturization for fasteners and precision gearing is expanding lines of stock items. In lock nuts and lock screws, the race is on for the smallest sizes. Applications so far are limited to optics, dentistry and cameras, but interest is evident in almost all fields, and suppliers are tooling up to meet expected demand. It is already possible to get quick deliveries on inserts, screws and nuts (with or without locking features) in sizes as small as #0-80 (0.060-in. dia); self-tapping inserts are as small as #2-56.

Production of miniature lightweight lock-nut plates, which are fastened to sheet metal with rivets, has brought a demand for smaller rivets. Grooved pins that were available only in sizes starting from ⅛ (0.094-in.dia) can now be obtained in 0.047-in. dia on special orders.

Miniaturization of precision gearing is leading to increased pitches to provide the same speed ratios and avoid undercutting. Pic Design Corp. and Dynamic Gear Co. now offer stock gears up to 120 pitch. However, inquiries at the show from many computer and small-instrument designers indicate a demand for gears up to 200 pitch. While suppliers are not stocking gears in these sizes they are accepting orders.

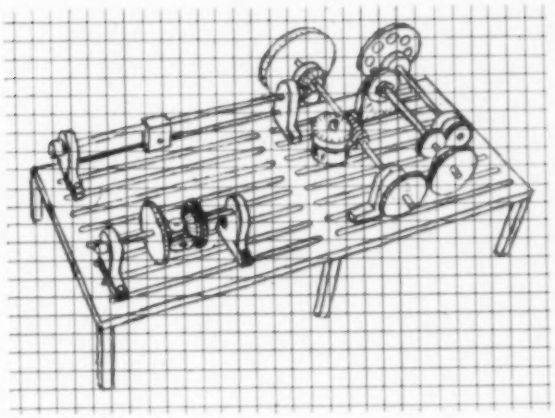
An increasing variety of "breadboard" accessories is offered by precision-gear manufacturers for use in research and prototypes. Components stocked include breadboard plates, gears, shafts, slip clutches, differentials, cams spring, shims. Thus a breadboard model (see sketch) of a problem can be quickly set up and tested. If the model is found satisfactory, it is "packaged" into a final housing. This simplifies ordering; one order form to fill out and one catalog to consult in place of dozens. This cuts down drafting and design time, and avoids getting parts such as shafts which do not fit correctly with other components. With only one supplier involved, there is less chance of delay. Components are designed for reuse, and kits include assembly tools.

Sizes Down, Ratings Up...

A continuing reduction in size of electrical components was strongly evident in snap-action switches, conventional rotary switches, relays, starters, and other standard electrical components. For the first time at this Show, the word "microminiature" appeared, replacing "subminiature" as a descriptive term; items formerly described as "fly" size are now "flea" size.

Ratings of electrical components are increasing: temperature rise, vibration and shock resistance. Improved insulation materials and better mechanical design of moving parts are responsible.

Identification of wires in cabling has been simplified by a new machine (by Brady) which automatically wraps an adhesive identification label around wires. Printed



wiring is now well established for wiring small panels. While it is not yet being used in larger sizes, it seems evident that complete control panels will soon use printed wiring.

Equipment exhibited shows that confidence in reliability of electronic controls is growing; components designed for industrial service are chalking up better service experience.

Aircraft-Marine Products, Inc., demonstrated a horizontal terminal applicator for splicing combinations of 3 wires, either solid or stranded. Terminals are designed to penetrate varnish insulation; stripping is not necessary.

Plastics Team Up...

Combining different plastics to do separate jobs in one material is emerging as an attractive alternative to the single plastic with omnibus properties.

For diaphragms, gaskets, pump packing and U-rings, International Packings Corp. has mold-bonded Teflon to synthetic rubbers. Resulting laminated material combines chemical inertness of Teflon with resiliency of the particular rubber used.

Phenolic, cotton cloth and Teflon laminate in ring form is molded to give smooth spherical inside surface for a large bearing race. This experimental material developed by Russel Mfg. Co., Middletown, Conn., is being evaluated by several helicopter companies for non-lubricated bearing applications.

Silicone-coated kraft paper as an alternative to polyethylene wrapping had short shelf life caused by silicone migration off the paper. Dow-Corning has solved this and other problems in a coated paper which is being evaluated by the Food & Drug Administration as an acceptable food wrapping. Another promising application is for interleaf between rubber sheets and finished plastic parts to prevent adhesion.

Vinyl tubing lined with fluorocarbon polymers for

carrying corrosive fluids has been developed by U. S. Stoneware Co. Outer cover of vinyl provides abrasion resistance and color coding, as well as reinforcing the inner tube.

Coming from General Tire & Rubber Corp., a new method of decorating vinyl sheet has delicate thread and pattern effects. Threads are worked into a light supporting mesh, laminated to the vinyl by an overlay of Mylar film for protection.

A silicone rubber sandwich built into Pyle-National electrical connectors gives increased resistance to environment. Rubber insulator rides between two floating rigid disks, absorbing shock and vibration, and making the contacts self aligning. Insulator is compressed to form an effective moisture seal when the connector is assembled. Aluminum shells have an anodic coating with a hardness of C40 and a dielectric strength of 1400 to 1800 volts.

Many New Ideas in Bearings

Thin-shell needle and roller bearings were exhibited by several manufacturers. Kaydon Engineering Corp. featured rollers with spherical instead of conical ends; grease retains the rollers in the flat-sided shell until assembly. Longer effective roller length increases capacity and life; a typical bearing has 41% more load capacity and 2.8 times the life.

Drawn-cup roller bearings shown by Torrington have a one-piece retainer which separates guiding and retaining functions. Guiding action takes place at the roller ends on the pitchline. Retainer segments ride shaft between the rollers and do not contact rollers after bearing is mounted on shaft.

New Departure demonstrated a full-complement ball bearing for 600 rpm at 1100 F. Bearing is designed for a low-speed jet engine accessory which operates in hot exhaust gas streams without lubrication. Bearing material is M2 high-speed steel. Balls are loaded to a Hertz stress of 50,000 psi, about 10% of usual value. Minimum service life is 24 hr.

Thomson Industries showed a nylon bearing liner for installation in thin plates and a C-shaped open-type linear ball bushing for supported shafts. The nylon liner is double flanged for retention, with one flange large enough to take thrust loads. Split construction provides a gap to compensate for temperature and moisture variations. The ball bushing is of standard construction with a longitudinal slot about half as wide as the bore to allow the unit to ride over shaft supports. The open sector is equivalent to the width of one ball circuit.

A high-speed magnetic counter made by Durant is rated at 1500 per min and has a fast electric reset, which can be operated without disconnecting the drive. Data readout counters delivering 100,000 different circuit arrangements, shown by Veeder Root, are compatible with standard data processing equipment. Counters may have mechanical or electrical drive and reset. Circuit capacity is 1 amp at 110 v, a-c or d-c with counter stationary; with counters driven during readout, capacity is 200 ma for a resistive load.

Electric clutches and brakes exhibited by Simplatrol Products Corp. included 4 in. and 12 in. sizes which extend the range of their small and miniature clutches. Rubberized fabric disk diaphragms provide flexure required for engaging armature to magnet.

Pre-finished Metals...

Need a portable electronic piano? . . . A full 88-key job is available from Wurlitzer. What's more, it's one of the newest applications of vinyl-coated metal, in this case aluminum with a pebble-finish vinyl coating made by O'Sullivan Rubber Co., Winchester, Va. This piano represents a continuing trend toward pre-finished metals in product design. Plastics and steel producers are spending heavily to keep up, even though they are not marketing products yet. (Example: Pontiac for 1958 is reported to be using a fair amount of vinyl-coated aluminum for interior panelling and trim.)

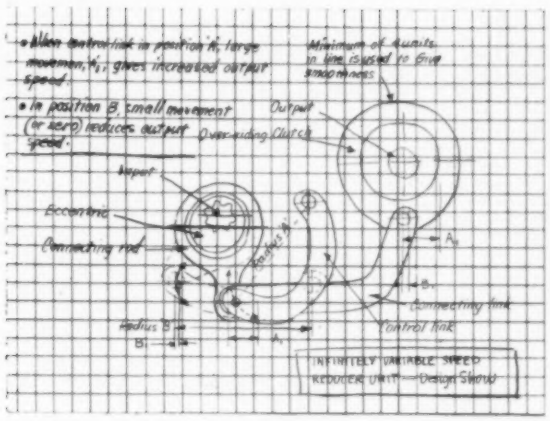
In addition to vinyls, pre-coated enamels are well established. A newer entry are the plastisol precoats, with patterns applied by roller to the sprayed coating coming along in the near future. Mylar is being used by Dobeckmun Co., Cleveland, O., to protect a wood grain pattern printed on vinyl pre-finished steel for TV cabinets.

Welding without injuring the coating has been a major obstacle to wider use of pre-finished metals; however, O'Sullivan has devised a method of studwelding fasteners to the steel side with no damage to the vinyl. Work on seam and spot welding is continuing.

Development also continues in pre-finished coatings of metal-on-metal. Here are two new continuous processes of considerable potential: A chrome surface treatment for steel, aluminum and other sheet metals is a development of Heinz Mfg. Co. Called "Hinac", the process is reportedly fast and inexpensive. It is used in the can industry as a replacement for tin where detergents are involved because it has a higher resistance to alkalis. National Research Corp., working with Crown Cork & Seal Co., has perfected a continuous vacuum-metallizing process for depositing aluminum on steel for containers (see Developments to Watch, page 10).

Variable-Speed Drives...

Broadening trends to automatic production have produced a narrower, but significant, trend in adjustable-speed drives. Not all drives shown were new, but nearly all emphasize smooth operation easily adjustable through



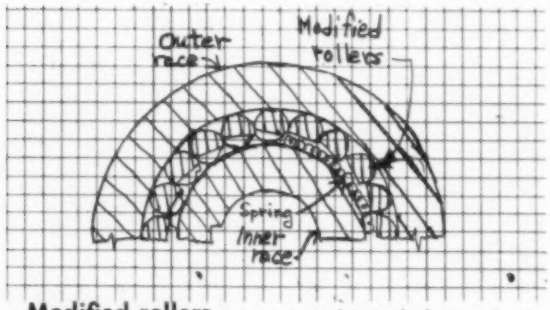
New over-riding clutch type . . . with infinite range has variable-stroke transmission with input shaft connected to output shaft by a series of linkages operating in phased sequence. Over-riding clutches control direction of power transfer. Speed reduction is controlled by changing length of stroke.

all ranges from fractional to multiple horsepower.

Methods used in drives exhibited were: Over-riding clutches controlling direction of power transfer; electronic-controlled d-c motors; sliding sheaves on belt drives; electro-hydraulic; and ball-and-disk drive.

Considerable development has taken place in over-riding clutches, torque limitors and coupling devices.

The "Inchworm" feed using magnetostriction as a driving force is embodied in a drive system for machine-tool feeds. Expansion and contraction of a nickel transducer, alternately clamped and unclamped, causes the work to be fed into the machine in micro-inch steps.



Modified rollers . . . are used instead of sprags in an over-running clutch developed by the Hilliard Corp. Roller contour produces the cam or wedge action. Contours and spring slots in rollers are designed so centrifugal force does not produce a couple about the roller axis. This controls free-wheeling resistance.

How they do it...

Bonding aluminum to stainless steel by diecasting is a new twist for large-scale production of parts requiring the accurate detail and lightness of diecast aluminum and the corrosion and wear resistance of stainless. The technique, developed by the Hoover Co. Casting Division, North Canton, Ohio, results in a high-strength bond with ductility about five times that of other bonding processes.

More intricate investment castings are possible through the use of water-soluble cores, now become a standard production tool, according to the Arwood Precision Casting Co., New York.

Friction welding of thermoplastics is a new development of DuPont. Rotational rubbing of two plastic surfaces melts and flows the plastic at the interface, producing a bond with the strength and clearness of the parent materials. The process is only applicable to parts with circular joints which rotate against each other.

High-temperature adhesives in sheet form as a possible alternative to furnace brazing is the latest fabrication news in stainless-steel honeycomb construction. Aircraft designers are currently evaluating two new entries: Rubber & Asbestos Co. has developed a film adhesive which will maintain a lap shear strength of 1500-2000 psi for 200-400 hr at 450-500 F, a current aircraft target temperature. Minnesota Mining & Manufacturing Co. now markets an epoxy film adhesive which develops a room-temperature lap-shear strength of 4000 psi, with a strength of 1670 psi at 350 F. Both films are oven-cured at about 350 F to develop optimum properties and are of interest in stainless-honeycomb work because of these moderate fabricating temperatures, thus reducing heavy tooling costs.

Fine-line definition in the reproduction of dials, calibration marks and scale divisions on metal is achieved by a no-etch anodizing process by North Shore Nameplate Inc. This is the first time the process has been made available in the United States. Multiple-color reproduction is available.

Automatic welding of tubes in tube-sheets or headers is replacing rolling in many heat-transfer applications. Welding produces a pressure-tight joint with lower stresses than tube rolling. Revere Copper, which developed the process, foresees applications in automobile-radiator, industrial heat-exchanger, aircraft and power-generating equipment production.

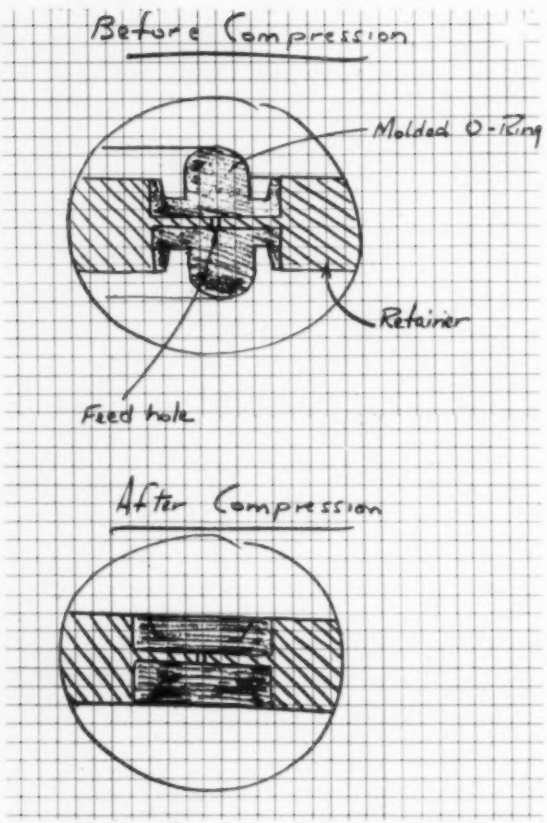
Hydraulic-Unit Sizes...

Manufacturers of hydraulic and pneumatic components are filling in their lines of valves and cylinders to cover complete flow and pressure ranges. Previously spotty availability in some smaller sizes has been reduced or eliminated.

Greater attention is now directed toward electrically operated pneumatic and hydraulic valves. In response to the need for automatic cycles, solenoid-controlled two-, three-, and four-way valves for high speed or delayed applications are now available from several manufacturers.

At least one company (Oilgear) has gone one step further to provide a complete servo package of an electrically controlled variable-delivery pump. When used to drive a hydraulic motor (coupled to a feedback potentiometer or rate generator) the servo will position the output shaft or determine its speed in either direction within 1%.

One drawback to these complex systems is the almost



A molded-in-place O-ring gasket . . . developed by F. C. Wolfe Co., Culver City, Calif., for aircraft is now available for the industrial field. Flexible gasket compound is molded into a metal retainer and spacer; when compressed, the section changes to oblong shape. Gaskets of complex outline can be made. Jet aircraft "wet" wings (see cover) are assembled using silicone O-rings under the rivet head to eliminate internal tank coating.

certain need for help in analyzing the complex mathematical relationships inherent in servo design. More servos will be used—that is obvious. Design engineers will have to call on specialists in designing and specifying servos for existing or future designs.

Suppliers are concentrating development on higher temperature and pressure. A gear pump is now available for service to 2000 psi with flows up to 40 gpm (Commercial Shearing & Stamping Co.). A flexible Teflon hose with braided wire covering will withstand 450 to 500 F (Stratoflex, Inc.). A metal-cored rubber O-ring will resist ring blowout at higher pressure (National Seal Div., Federal-Mogul-Bower Bearing, Inc.).

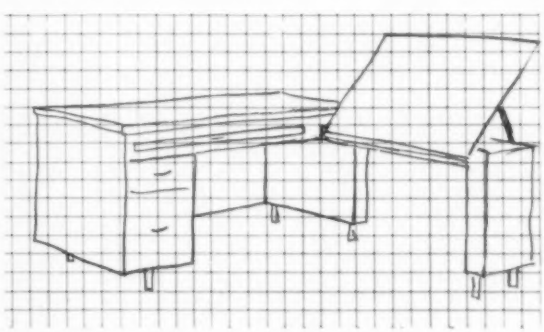
Do-It-Yourself PVC, Teflon

Plasticized PVC compounds with their easy handling and curing characteristics are making "basement inventors" of many design engineers . . . to management's delight, according to Firestone Plastics Company. Two typical products emerging from such tinkering: New automobile air filter with fluted cloth-filter element and protective screen held together by cast-in-place PVC rings top and bottom; corrosion-resistant and anti-skid treadplate in which grating is dipped in PVC, abrasive particles sprinkled on, and the combination oven-cured.

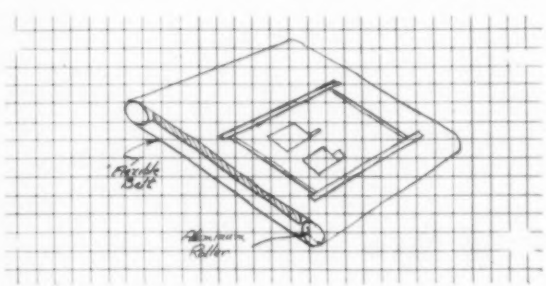
Teflon-lined pipe will soon be made easier and cheaper by a new development of the Resistoflex Co., Belleville, N. J. The idea is to produce a separate Teflon pipe liner, with a backing of glass-reinforced polyester, for insertion by the customer into standard pipe. Already developed are compression-type flange fittings for linking successive pipe lengths, Teflon-lined flanged elbows, and flanged bellows for expansion joints; a Teflon-lined flanged Tee is under development.

Drafting Highlights

Accent is also on more stable drawing materials. Keuffel & Esser Co. now supplies stabilized Mylar films with different coatings suitable for original drawings, tracings and scribed drawings. These may serve as templets for optical comparators, printed circuit boards, or actual parts to be machined. Charles Bruning Co., Inc., manufactures a photosensitive emulsion that may be sprayed on metal and printed from transparent drawings with a carbon-arc lamp.



Draftsman dignity and morale . . . influence design of this L-shaped work area. Originally tried by GE and made by Hamilton Mfg. Co., the desk is at left of a board set at 55° optimum, but adjustable to 90°. Result: designer is both desk and board man.



Belt on a drafting board . . . also attacks the time-honored high stool. Draft-a-Matic (General Fireproofing) has an endless belt to which the drawing is taped. It can be rolled up or down as needed. Other designs have fast-release (pedal or lever) tilt and height adjustments.

TECHNICAL NEWS

Is Justice Delayed, Justice Denied?

Inventor's Compensation Must Wait Until "International Conditions More Settled."

Dr. Otto Halpern is an inventor. And, like most inventors he hopes to get a patent on his invention, so that he can sell it at a profit, or license its manufacture on a royalty basis.

But with Dr. Halpern it is not that simple. His invention is of such importance to the national security of this country that it can only be described in carefully couched terms permitted by the Navy: "A manner and means whereby an object may escape observation by radar." It follows therefore, that this invention was affected by United States Code 35–Patents, paragraph 181. . . . "If, in the opinion of the Atomic Energy Commission, the Secretary of a Defense Department, or the chief officer of another department or agency so designated, the publication or disclosure of the invention by the granting of a patent therefor would be detrimental to the national security, these three departments or agencies shall notify the Patent Commissioner and the Commissioner shall order that the invention be kept secret and shall withhold the grant of a patent for such a period as the national interest requires, and notify the applicant thereof. . . ."

Dr. Halpern has been affected by this law since 1945 when he applied for a patent for his invention. His application for a patent was allowed in 1951, but since it contained secret information it was not permitted to issue, or be made public. (A patent does not begin its 17 year tenure until the date of issue.) Nevertheless, it did permit Dr. Halpern to ask the government for financial compensation as a result of the government's use of the invention. The same U.S. Code 35–Patents–it states that: "The right to compensation for use shall begin on the date of the first use of the invention by the government".

From 1952 to 1954 Dr. Halpern asked for some compensation, but without success. The Navy said, at different times: "There is no merit to your request for compensation." Then later: "There is no invention" (meaning that previous information on this subject prevents it from being called an invention). This was difficult for Dr. Halpern to comprehend, for: (1) The application for a patent was already allowed; (2) For 10 years the government regarded it as so highly secret that no information on it could be released. (Dr. Halpern could not find out if his invention had been used at all.); (3) The Navy wanted the invention assigned to the government.

The Navy's Offer

Finally, the Navy offered a lump sum settlement which Dr. Halpern considered inadequate. The Navy wanted to consider this settlement in effect a "paid up license" for the past twelve years of use under the secrecy ban, plus any use under the future secrecy ban, and all use after the license issues–which is 17 years. This will add up to a period of at least 30 years. Spread over this period, the Navy's offer amounted to less than $1000 a year. Dr. Halpern wanted an annual royalty based on any future use of his invention by the government, with compensation for all past use settled in another manner.

In April 1956, Dr. Halpern brought suit against the government for a fair and adequate compensation. (A special statute in the patent law applying to inventions permits the inventor to sue the government, without requesting the government's permission, for damages caused by the secrecy order.) Several weeks ago when the case finally appeared before the U.S. District Court, Southern District of New York, Judge David Edelstein dismissed it on the basis of a claim from the Secretary of the Navy. This claim said that all documents, statements, or testimony related to the subject are military secrets, the release of which would prejudice the country's security.

In other words, Dr. Halpern did not get his day in court because the subject was too secret to even talk about. But the government did not deny him a trial; merely postponed it "until such time as the potential enemies of the United States have the secret of the technical matters involved herein or until international conditions are more settled." If such is the case Dr. Halpern's heirs might well be the recipients of his efforts.

There is a way to settle this question and Dr. Halpern and his attorney plan to ask for it in their appeal to a higher court, the Circuit Court of Appeals. That is: a secret trial where all the participants will have to be cleared for security so that a discussion of the invention and its military and potential commercial applications will be permitted. There is nothing in the statute to deny such a trial, and Judge Edelstein could have taken this action had he chosen to do so.

But why should an inventor be forced to carry the fight this far before he can get a just settlement? The small inventor cannot afford this. He is therefore coerced through delaying tactics, and "take-it-or-leave-it" offers to accept compensation. He is told that his request for compensation has no merit, and he is not even told if his invention is being used. In Dr. Halpern's case, the Navy finally broke down and said it is being used "very little." It should follow, then, that some company profited when it made one or more of these devices for the military. If a manufacturer makes a profit on this invention, it seems strange that the inventor does not profit also.

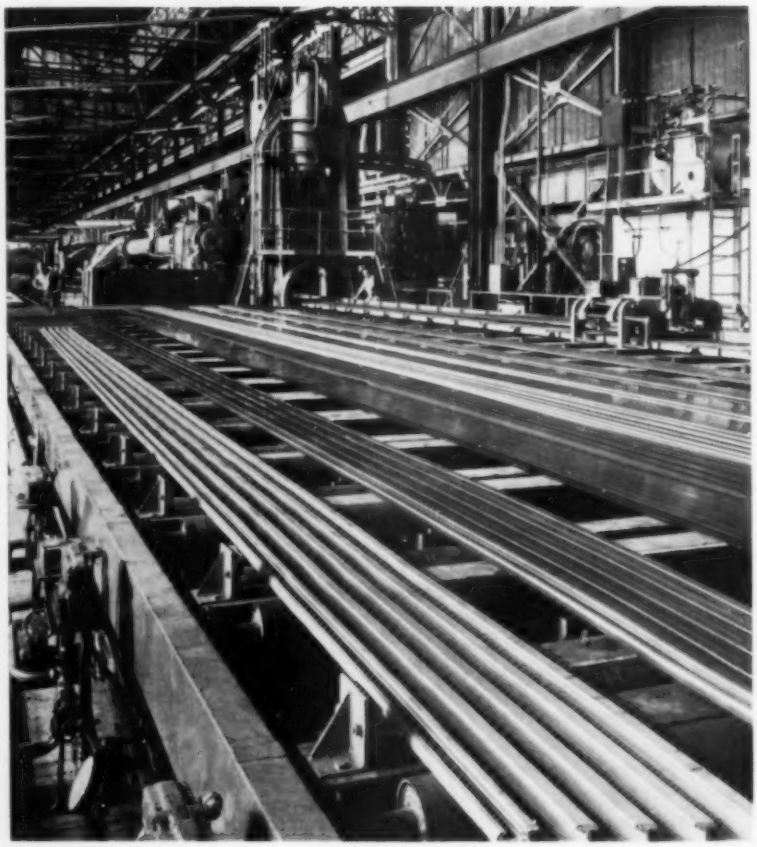
Instead, since 1945, Dr. Halpern has paid many thousands of dollars in legal fees alone to carry his fight this far. A nuclear physicist, Dr. Halpern has been professor of physics at New York University, Columbia University, and the University of Southern California. Born in Vienna, he came to this country in 1930 and became a

citizen in 1936. In 1941 he brought his invention to the attention of the National Defense and Research Council. Dr. Halpern was then asked to develop certain military applications of his device at the Radiation Laboratories operated by the Massachusetts Institute of Technology in Cambridge, Mass. A patent application on his invention was filed in this country in 1945, and in England one year later. Both have been allowed, but kept secret.

Dr. Halpern is the first to admit that his invention cannot at this time be exploited commercially, because it would reveal the true nature of the secret of the invention. This most lucrative avenue must be closed off indefinitely until the world situation changes for the better. When will that be? Dr. Halpern is now 58; he was 46 when he applied for a patent on his invention. How is compensation to be made? With the Navy there is no special fund to reimburse inventors. Any settlement must come out of current procurement funds.

One suggested solution might be a committee consisting of representatives of business as well as the military, so that a discussion and fair estimate of the commercial worth of the product can be made by people familiar with the field to which the invention is related. Certainly this approach would be preferred to some of the arbitrary methods now being used. Ironically, some of the manufacturers asked to judge the possible commercial worth of this invention might be already producing and profiting from the manufacture of the inventor's product for the government.

An inventor, who knows of the difficulty he will have dealing with the government, might well take his invention to the open market for sale before he requests a patent. The risk he is running here is two-fold. He might be accused of being unpatriotic, knowing that his invention has potential military value. Or, some company might steal his idea or pay him very little for it. Nevertheless, if the delays, refusals, and insults experienced by Dr. Halpern are any indication, such a move on the inventor's part is bound to be more profitable—and certainly quicker—than dealing with the government. It might be added that the government loses in the long run.



Larger Magnesium Extrusions Offer Design Advantages

Originally designed for Germany's I. G. Farben magnesium division during the latter days of World War II, this 13,200 ton press is now extruding magnesium at Dow Chemical Company's Madison, Ill. mill. Dow purchased the press from the Air Force in 1953.

The largest press in the world for extruding magnesium, it is capable of extruding integrally stiffened sections from 9 to 20 in. wide; I-beams from 11 to 28 in. high; and round tubing from 10 to 24 in. O.D.; and all shapes common to conventional equipment. A double locking frame permits complex stepped extrusions, and combined hollow forgings. Using the integral 3000-ton piercer and double locking frame in conjunction, hollow propellers have been extruded.

Billets from 16 to 32 in. inside dia can be made into extrusions up to 80 ft long. Pressure stages are 3,000, 5,500, 9,700 and 13,200 tons. With a maximum hydraulic pressure of 130,000 psi on 16 in. billets, and 50,000 psi on 26 in. dia billets, this high pressure ratio will permit the extrusion of thin-walled or bulky shapes.

With the higher pressures available allowing lower extrusion temperatures, the compressive yield strength (cys) of extruded parts will be increased. For example: the cys of the ZK60 alloy extruded at 700 F is 34,000 psi; extruded at 500 F, the cys is 37,000 psi.

The press also can extrude forging stock up to 18 in. in dia. Eventually Dow expects to offer extrusions as heavy as 3000 lb up to 32 in. in diameter.

Already turned out of the new press are 18 in. structural sections for portable landing mats for the Corps of Engineers. Greatest potential for the machine, according to Dow, is for

round hollow tubing for missile bodies.

Speed of the press is 16 full-stroke extrusion cycles per hour of 71 in. long ingots, including the piercer operation.

Auxiliary equipment is an automatic 1000 ton capacity stretcher which will handle extrusions up to 80 ft long and 40 sq in. in diameter.

Just Started . . .

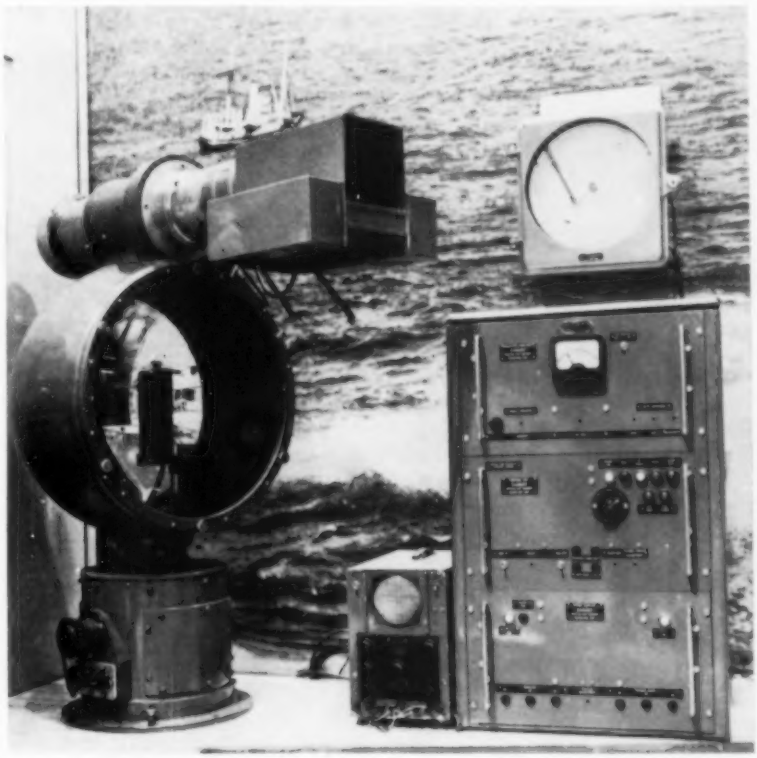
More than 200 members of the ASME have indicated interest in a new group formed by the Society to deal with the more complex engineering problems found in keeping industrial equipment in operating condition. Object of the group will be to cover such topics as the modification of equipment and facilities to reduce or eliminate maintenance problems, and suggest corrective measures, including the development and use of special instruments, plus managerial activities such as organization, planning and keeping of records. Chairman of the group is Guerard Mackey of the Engineering Dept. of the E. I. duPont Co., Wilmington, Delaware.

Just established by the Board of Trustees of Manhattan College is a Council on Engineering Affairs, the purpose of which is to bring together key men representing civic, commercial, military, industrial and professional interests. These men will help the college give proper shape and direction to The School of Engineering. Chairman of the Council, Charles E. Wilson, former president of the General Electric Co., feels that the Council will link the men of action who represent industry with the men of thought who represent education.

New York University will establish at Bell Telephone Labs this fall a graduate study center to permit certain laboratories employees to earn advanced engineering degrees by attending classes during regular business hours while receiving full-time pay. The new program will replace a part of the Communications Development Training program now in operation at Bell Labs. The latter program was set up in 1948 as a 3-year company course to offer additional education and training for newly employed engineers. The two programs will now complement each other.

To provide a meeting place for more than 53 engineering and technical groups, a $1\frac{1}{2}$ million Engineering and Scientific Center is under construction in Cleveland. Although the building fund campaign is still short of its goal, urgings by industrial and community leaders and by representatives of member groups of the Cleveland Technical Societies Council have prompted the Board of Governors of the Cleveland Engineering Society to start construction. The Center will be two and a half story structure with a five story tower and approximately 50,000 sq ft of floor space. It will contain a large auditorium seating 900 and an additional slanted-floor auditorium to accommodate 150 people.

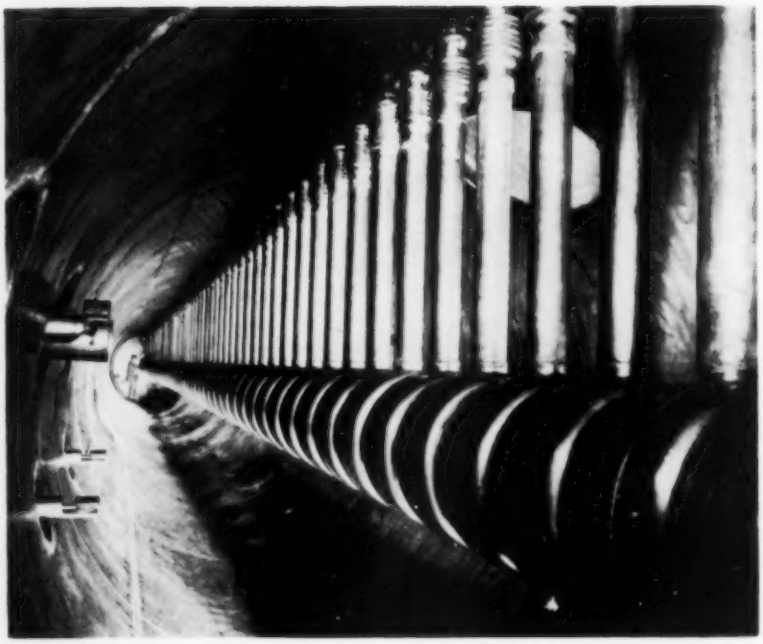
Founded in 1956, a relatively new organization known as the Western Regional Strain Gage Committee, is a group composed of aircraft manufacturers and governmental agencies devoted to the study of strain gage problems. Some 30 divisions of fourteen industrial units are represented at the committee meetings. The group is not affiliated with other societies or organizations. Committee meetings are round-table one-day discussions with participation by delegates from the member companies. The committee, whose offices are at 300 W. Boston Ave., Las Vegas, Nevada, states that it is not seeking any additional members at this time.



FOG ON PAPER, in the form of meter readings or printed records, is possible with the first electronic fog detecting device ever to have been developed. The detector can give an accurate assessment of visibility within three miles by day or night in snow, mist, rain, or fog, and can switch fog sirens or other poor visibility warning devices on and off. Developed primarily for use at sea, the detector is reported to have wide possibilities for airfield work. Designed by Stone-Chance Ltd., St. James Square, London W1, England, the device works by electronically measuring the light reflected back from a searchlight beam by water particles in the atmosphere.

TECHNICAL NEWS

New Atom-Smasher Goes Into Operation



Ninety feet long and ten feet in diameter, this new type atom-smasher has just gone into operation at the University of California's Radiation Lab., Berkeley, Calif. This "post-stripper" has 68 doughnut shaped drift tubes through which particles are accelerated to their ultimate energy of 10 million electron volts per nucleon. Inside each drift tube is a strong focusing quadropole magnet, a new development in accelerator design.

A linear accelerator designed for the study of elements in the transuranium region, including an attempt to synthesize atoms heavier than element 101, the machine is now accelerating nuclei of nitrogen atoms (nitrogen 14) to energies of 140 million electron volts. The new instrument does not compete in energy with such powerful machines as the bevatron, which accelerates protons, the nuclei of hydrogen to 6.2 billion electron volts. It was designed especially to accelerate the nuclei, or ions, of very heavy atoms, and is consequently called a heavy ion accelerator, or as it is known, the "Hilac."

A joint project between the University of California and Yale University, the development of the Hilac now permits the synthesis of elements heavier than mendelevium (element 101), the heaviest now known. Elements heavier than uranium, element 92, are all synthetic, and are obtained by transmuting uranium nuclei step by step into successively heavier atoms.

The new atom-smasher will permit a new type of exploration of nuclear forces, and will open up a new field of study of elements 84-90. It will be used in studies of the effects on living cells of very heavy particles like those found in cosmic radiation beyond the earth's atmosphere.

Standard Samples Control Industry

Back in 1905 the American Foundrymen's Association turned over to the National Bureau of Standards its project on the standardization of four types of cast iron. After these irons were reanalyzed by the Bureau chemists and a number of industrial and commercial laboratories, the Bureau distributed these samples. Shortly afterward, a similar program for steels was started.

This was the beginning of the Standard Sample Program of the National Bureau of Standards. It has since been expanded to cover a wide range of scientific work, and the Bureau now prepares and makes available to industry 575 different materials of certified properties, purity, or composition. If a new program is accepted, it will mean an additional 87 new samples in the next 2 years. Money for such a program is for instrumentation. Also needed is more cooperation from industry in testing to permit a comparison of results. This analysis takes from 2½ to 5 years to collate the cooperative analysis, etc., and set up a standard sample. It is hoped that this time can be reduced to 2 years.

In 1943, during World War II, standard samples of two tin ores were urgently needed. At the time, the Pacific areas from which tin had been obtained before the war were closed and new sources had to be obtained. The quality and composition of available tin ores were compared using the Bureau's standard ores as a basis for evaluation of the new sources.

Also, during the war, the need arose for hydrocarbons having a high purity, particularly in the development of synthetic rubber and aviation fuels. In a year the Bureau issued its first standard samples of hydrocarbons.

Recently, a law was passed which permits NBS to keep the funds obtained from companies and individuals who buy these samples. During 1956 a total of 32,501 standard samples were purchased for a fee value of $136,784. Federal and state laboratories got 2500 free samples totaling $23,000.

The metals industry needs standards for the alloys they make, and with modern spectrometric analysis, they can get an analysis back in minutes after a test pour. But spectrometric methods too must be standardized

Machine Tool Obsolescence

New developments in the machine tool industry, particularly in the field of controls, have enabled machine tool builders to make vastly improved machines so that older models become obsolete faster than ever before. This was the view of J. A. Raterman, President, Monarch Machine Tool Co., and National Machine tool Builders Association, in a speech at the 21st Annual Machine Tool Electrification Forum, sponsored by Westinghouse Electric Corp., in Buffalo, N. Y.

J. F. Randall, Director, Manufacturing Engineering Office, Ford Motor Co., pointed out that obsolescence in the automotive industry is greatly increased by the frequent product design changes. A good estimate places the total cost of obsolescence in this industry over a three year period at $320 million. In the past three years the cost of facilities actually retired was about $80 million. During the same period, product design changes in the industry have required an expenditure of about $240 million more to rework existing facilities and purchase new machines.

Mr. Randall cited a case that cost Ford $3 million because the intake manifold for the old and new engines, a few years ago, were significantly different. This broke down to a loss of $500,000 loss on the retirement of the old machinery (after just a few years use) and an investment of $2.5-million for new in-line transfer machines for the new engine design.

Throwing out a challenge to machine tool builders, Mr. Randall said that, "Frequent product design changes and the relatively inflexible characteristics of many of our present machine tools are among the factors causing high obsolescence in the automotive industry." He added that interchangeable machine components, unitized hydraulic and pneumatic systems, and unitized electrical plug-in controls will help cut these high costs."

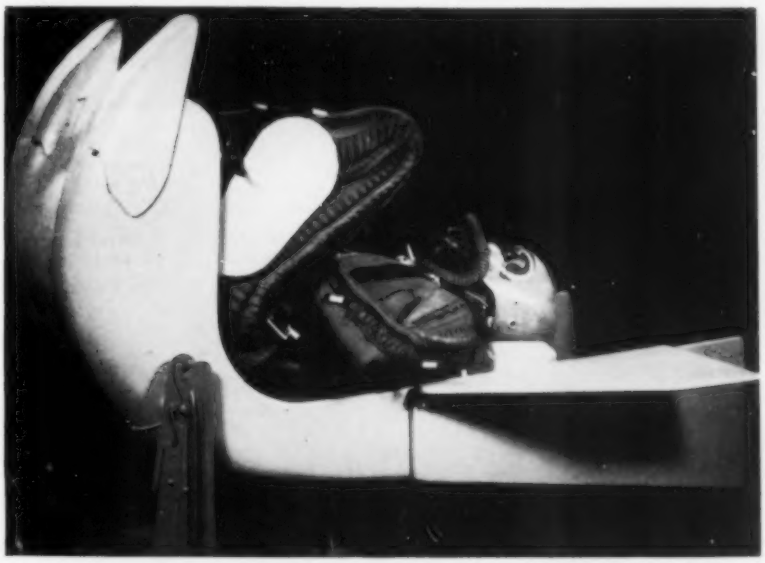
Also described at the meeting was a new Westinghouse semiconductor device called the Dynistor diode, which has some characteristics of a transistor and others of a diode, and is said to offer some outstanding potential applications in power control. The dynistor diode has been operated with continuous currents up to 4 amp, and in special applications up to 11 amp. Under pulsed conditions it has passed 500 amp and in 5 microsecond pulses.

A new concept in automatic controls, called Teleological Control, was introduced. This type of control is allowed to experiment with the process until it finds the goal as determined by a set of built-in rules. This is unlike the conventional controls which force the controlled process to conform to their instructions. The idea for this new control stems from the fact that there are many processes which can be operated only by human operators—whose efficiency is subject to question. Automex is the Westinghouse trademark for this type of control device.

with standard samples.

Principle uses of the standard samples are checking methods of analysis; standardizing volumetric solutions; checking improved methods of analysis, calibration of instruments used in such analysis, and to maintain a uniformity of finished products. Specifically, the output of the iron and steel industry is controlled by these samples; hydrocarbon standard samples control the mixtures that go into plastics, synthetic rubber, and automotive and aircraft fuels. Standard pigments also control paint colors.

Of the 575 different standard samples, about 200 are certified for chemical composition. Others are certified for such properties as acidity, viscosity, melting point, density, index of refraction, heat of combustion, color and gloss.



YES, THIS PILOT IS IN THE CORRECT POSITION—prior to being ejected from a plane at supersonic speeds. Called the "aerial bobsled" ejection seat, it rotates the pilot and the seat 90 deg. into the supine position before it is separated from the cockpit.

Pulling the D-ring on the seat automatically reels the pilot's boots into the stirrups. These and the seat pan then curve upward, pulling the pilot's knees against his chest at the same time that his arms, shoulders, and head are supported in place against the seat. An explosive charge starts the seat up the rail and on its way out of the cockpit. For the first 19 in. of its upward path the seat remains in its normal position. Then a scissors carriage rotates the man and the seat backward through a 90 deg arc. By the time the seat has cleared the cockpit, the pilot is lying on his back. Less than a second has transpired. A small rocket engine in the seat is then ignited and the seat leaves the plane. Stabilizing fins slide upward and fold out automatically. Thirteen major aircraft companies and subcontractors are participating in the multi-million dollar pilot escape system development program, with Convair assigned as the coordinator of the upward pilot escape system for supersonic aircraft. Lockheed Aircraft has the same responsibility for the development of a downward escape system.

NEWS IN PICTURES

FIND THE PROPELLER on this unusual looking plane designed by Rhein-West Flug Fischer & Co., Porz-Westhoven, Germany. With a wingspan of about 49 ft, the RW-3 Multoplane, as it is called, serves as a motor glider. But, by removing an 8 ft section on each wing and installing reserve fuel tanks there, the plane is changed into a powered touring plane. The designer feels that with the propeller directly in front of the rudder, and the elevator above the propeller slip stream, instead of blowing against the plane, the propeller in the rear removes the air flowing around the fuselage by suction to prevent any turbulence. When gliding with the engine shut off, the propeller is moved into a slot to reduce the drag. The propeller arrangement also increases safety, as the blowing against the rudder prevents any crash due to spinning with the motor running. The airframe is of welded steel tubing. Also, the plane is designed so that a turbo-jet engine can be installed if desired. Present power is with a 65 hp Porsche engine; a 130 hp engine is under development. At 1000 flying hours annually at about 110 mph, cost per hour is less than $4 per hour. Present plane cost is about $5500.

FIND THE SMOKESTACK on the first guided missile, nuclear-powered cruiser. To be called the U.S.S. Longbeach, the vessel is scheduled for the fiscal 1957 Navy shipbuilding program, and will have two pressurized water reactors for its propulsion equipment. The new cruiser is designed to operate offensively and independently of other forces during nuclear warfare, and can operate against planes, guided missiles, surface or submarine attack singly or in support of other forces. Besides carrying equipment for detecting and sinking submarines, the cruiser will use most of the Navy's guided missiles, including the Regulus II, the Talos, and the Terrier. The smokestack?—there is none.

HIGH-SPEED PHOTOGRAPHY stops the action of a new type all-plastic fan to show the design principle used. The vanes are mounted parallel and perpendicular to the axis, and no spill off or turbulence zone is created. With the complete shroud removed (left) the rotation of the bullet-shaped cone keeps the air moving in a direct line. The inset view (lower right) shows the fan with shroud attached. Direction of rotation has no effect on the direction of flow. Designed by Tru-Scale, Inc., Wichita, Kansas, this fan and 26 like it will be used to exhaust chemical fumes in the Monsanto Chemical Company's new Inorganic Chemicals Div., research laboratory in St. Louis, Mo. Tru-Scale says that this new design concept combines the high efficiency of the propeller or axial type fans with the ability of centrifugal-type fans in working against high static pressure. Other advantages claimed are: quieter operation; an efficiency factor equal to or better than that of any other fan on the market; a streamlined configuration requiring 25% less profile than comparable centrifugal fans; corrosion, fatigue, and spark resistance; and lower initial and maintenance costs. Other applications are in air conditioners, automobile heater blowers, forced draft blowers in residential furnaces, and small blowers for cooling components in large electronic housings. The fan shown here has a capacity of 1000 to 2100 cfm at 1200-1700 rpm, with static pressures of five-eighths to more than one inch of water gage. Tru-Scale says that Monsanto has requested a similar 450,000 cfm unit.

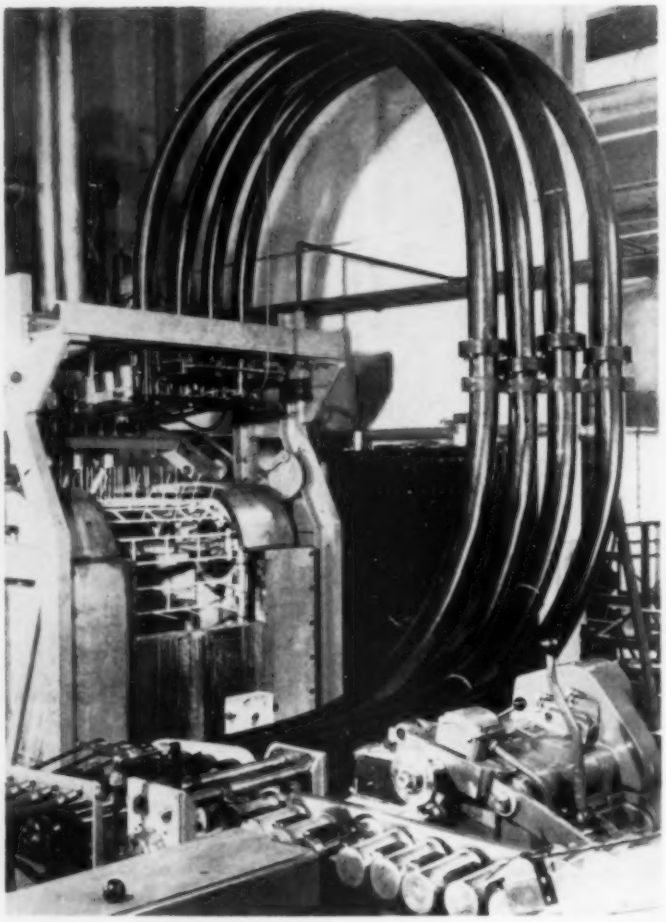
FRAGMENTS of three one inch steel balls lie in plastic trays as a result of flying apart from centrifugal force. This materials study by the Physics & Instrumentation Dept. of General Motors Research Staff, G. M. Technical Center, Detroit 2, Mich., is expected to produce information related to the effects that various metal-working, finishing, or polishing techniques have on the strength of various ball steels. The balls are magnetically suspended and rotated at great speeds in a vacuum, with some reaching 700,000 rpm before flying apart. In the plastic trays, right, the ball at left almost fragmented into four sections. The ball in the center tray fragmented into smaller pieces and among them (left of center) is a section shaped like an apple core, which formed the axis of the ball. Held above the trays (left) is a ball that became ellipsoidal from centrifugal force, compared with a normal spherical ball at right.

Aluminum Can Manufacture Goes Automatic

Seamless, rigid aluminum cans are rolling off a completely automatic line at the German subsidiary of Aluminium, Ltd., Montreal, Canada. Based on the impact extrusion process, the line at Aluminiumwerke Goettinger Gmbh, Goettingen, Germany, takes aluminum slugs resembling silver dollars and turns them into finished decorated, seamless cans in one continuous operation. These cans are being sold in Germany at prices comparable with cans made of tin or black plate. The cans are leak-proof and rust-proof and have longer shelf life. And because of their light weight, the cans will save shipping costs and stack better.

Eventually, according to Aluminium, Ltd., there could be added to this process a continuous casting unit in which primary ingot would be melted down, converted into a continuous strip of aluminum, and from this strip slugs would be punched out and fed continuously to the press. The present equipment will handle cans from 2 to 3 in. in dia and 2 to 6 in. tall.

The AC line, as it is called, consists of five units: (1) a press to make the can body; (2) a finishing group where the can is trimmed to length, flanged or beaded, and base modified if it is to be used as a pressure container; (3) a degreasing machine and a drying oven; (4) internal lacquering equipment and stoving oven; and (5) coating and offset printing machines and stoving oven. Change-over for making



FROM THE horizontal extrusion press where the can bodies are made, the cans are gravity fed to a machine for trimming, flanging and forming of the can base. The finished cans are delivered to four pneumatic transfer tubes and sent to the degreasing unit. The equipment will handle cans from 2-3 in. in dia and 2 to 6 in. high.

ALUMINUM CANS shown here are, left to right, beer can, edible oil container, small coffee can, and automobile oil can. The beer can is the most difficult to make, and requires all of the units of the line: impact extruded; dished in the base; trimmed and flanged, after degreasing it is internally lacquered and stoved; and printed with a base coat and decoration. Aluminium, Ltd. considers it entirely possible for canners to set up the can-making facility adjacent to the canning plant.

cans of different sizes is relatively simple, and under normal conditions, three men should be able to do it in about two hours. A typical change-over would require replacement of the impact extrusion tools, and the tools of the trimming, flanging and base forming machines. For different diameters, the transfer conveyor of the latter group and the mandrels of the coating and printing machines also must be replaced.

For handling the aluminum cans automatically, plastic pneumatic tubes were set up, through which the cans are either blown with compressed air or sucked by a partial vacuum. This type of system will handle a wide variation in can size without major adjustments to the equipment. Machinery for handling tinplate cans cannot be used for aluminum cans.

Germany Has Engineering Education Problems

Germany has a dangerous lack of technical education facilities and teachers, according to two independent investigations by the Ministry of Interior Affairs, and the German Research Association, Bad Godesberg, Germany.

The eight West German technical universities presently employ a total of 450 professors, plus 1253 assistants and engineers. The German Research Association claims in its report that a minimum of 25% more professors, and 62% more assistants and engineers are required. In the electrical engineering field alone, the German technical universities need new apparatus valued at $3.5-6 million plus $510,000-830,000 for salaries and experimental materials. The backlog of physical measuring equipment in German industry is about $8 million.

The Ministry for Interior Affairs, in confirming this lack of teachers and equipment, feels that the number of technical universities is sufficient, but that the number of engineering and machine building schools (non-university level, and shorter education) must be increased by twenty. With present facilities, only 59,000 mechanical engineers will be available by 1970, while 89,000 will be needed. The respective figures for electrical engineers are 39,000 and 50,000.

SEAC Search to Aid the Patent Office

In conjunction with a recent Western Reserve Symposium on Information Retrieval, the U. S. Patent Office and the National Bureau of Standards put the Bureau's SEAC computer to work searching through chemical patents to determine whether a chemical compound had been previously discovered. This is the first step in a long-range program to use automatic machines to help patent examiners. To determine whether the ideas in a proposed patent are new, the patent examiner now must search through many other patents in the technical library of the patent office.

This effort to use electronic data processing techniques is the result of recommendations of the Advisory Committee on the Application of Machines to the Patent Office, headed by Dr. Vannevar Bush.

In the test search connected with above symposium, a picture of an organic structure was flashed on a screen at the meeting in Cleveland. This structure was then changed to information that could be sent to Washington, D. C., via teletype. As it arrived on the teletype at the Bureau of Standards, it was automatically checked for accuracy and translated to code and fed into the SEAC.

Structures of 137 chemical patents, which had been stored in coded form, were searched to see if any of them had the chemical structure claimed in the "new" structure. Each patent averaged about 40 compounds each, indicating the amount of information that must be searched. This was not a patentability search; merely a search to see if this chemical structure had been cited.

Two searches were made. On one, a chemical structure similar to the new one being checked was found in the stored group. The computer stops its search at this point until the necessary information is obtained, then continues on its search. In the second search that of another compound, an error was found in the coded input material. After this was corrected, the search continued, finding one similar chemical structure.

Plans for New Plants and Equipment, 1957-1960

Industry already has plans to spend almost as much on new plants and equipment, as an average for 1958, 1959, and 1960, as it did in 1956, which was a record-breaking year. Industry also will spend more on research and development, which means that the chances are good that a batch of new products and processes will be announced before 1960. This is the prediction from the 10th Annual McGraw-Hill Survey of Business Plans for New Plants and Equipment.

The companies with the highest sales expectations, and the largest plans for capacity increases, are the capital goods industries: machinery, electrical machinery, and transportation equipment. Company sales forecasts work out to a 26% increase in sales by 1960 for manufacturing as a whole. As plans for new capacity taper off, industry plans to modernize. In 1957, plans call for 52% of capital spending to be an expansion and 48% for modernization. For 1958-1960 these figures are almost reversed.

Plans for research expenditures in 1957 total $7.3 billion—up from $6.1 billion in 1956, and $4.8 billion in 1955. But by 1960, industry will be spending $9.3 billion on research. Big spenders are aircraft manufacturing, with machinery, electrical equipment, instrument, oil and chemicals industries close behind.

While it takes time to turn research into commercial products, there already is an increase in the number of companies that are making significant capital expenditures to bring out new products. In manufacturing as a whole, 32% of all the firms expect to make such expenditures in 1957 compared to 28% in 1956. The individual industries (steel, nonferrous metals, electrical machinery, transport equipment) show much stronger gains.

Manufacturers now expect 10% of 1960 sales volume to be in new products (not made in 1956) for manufacturing. For machinery and electrical machinery this figure will be 20%.

NEWS BRIEFS

Starting salaries for engineers at the Boeing Airplane Co., Seattle, Wash., have increased 13% each year for the past two years according to the Seattle Professional Engineering Employees Association. The Association, in negotiating for a new contract wants to have the salaries of established engineers adjusted annually on the basis of increases in salaries paid new hires. The average hiring salary of 258 engineers, age 25 and younger, who were hired last year at Boeing's Seattle and Renton plants was $459 a month. This compares with $403 a month in 1955, and $363 in 1954.

According to Sidney Olson, V.-P., Olson Radio Warehouse, Inc., Akron, Ohio, large component parts distributor, three or four cash paying distributors are saving hundreds of small electronics manufacturers from extinction today because of the tight money market. He said, "Those in the electronics industry can expect this situation to exist as long as the money scarcity continues. We still have with us the hard pressed smaller company which cannot afford to wait 90 to 120 days for payment. In many cases immediate payment for a large order spells the difference between staying in business or going bankrupt. Ever since money began to get scarce, we have been receiving about one call a week from small manufacturers who want to get started on a new model but do not have the cash. Their only recourse is to sell the entire old line to us. We get a better price, and he gets the working capital he needs to stay in business."

Larger television screens might be possible as a result of work going on at the Westinghouse Research Laboratories to eliminate the black and white horizontal scanning lines now visible in a close look at a TV picture (above). Elimination of these scanning lines is done by splitting in half one of the tube's cylindrical metal "grids" used to focus the electron beam. A method of wobbling the electron beam vertically as it makes its repeated traces across the television picture tube broadens the white lines which carry the picture information and narrows the black lines which lie between them. If this line structure is reduced, larger pictures can be viewed at shorter distances. With a line structure reduction the average viewer sits about 6 feet from a 24 in. picture rather than at a distance of 11 feet without it.

A refractory cement which will hold metal to metal, glass or ceramics in temperatures from —420 to 1000 F has been developed to attach surface temperature transducers, strain gages, and lead wires to the skins of guided missiles. Dielectric and highly shock-resistant throughout its temperature range, the upper limit of the adhesive can be extended to 1500 F by modifying the composition. A joint of the cement, called CA-9, between two pieces of metal will resist 80 psi of shear force at room temperature up to 900 F. It is unaffected by 15 min of 45G vibration through one inch double amplitude at 1500-cps. The cement is air-dried for 6 hr at 60 F and cured at 300 F for 2 hr. Compositions are available with different curing times. The cement, which is composed of ground phlogopite, a polysiloxane polymer, and refractory oxides, is made by Charles Englehard, Inc., 850 Passaic Ave., E. Newark, N. J.

Germany was the biggest foreign exhibitor at last month's fair in Lyon, France. While French firms predominated, 450 German firms were represented out of 1200 foreign firms.

Three patent bills have been placed before the Senate from the Senate Judiciary patent investigating subcommittee. The bills are: S1862, which will make the Patent Office an independent branch of the government. It is now part of the Commerce Dept.; S1863, which will limit the life of a patent to 20 yr, starting with the date of application, instead of its present limit of 17 yr after it is granted; S1864, which will increase membership of the Board of Appeals from 9 to not more than 15.

Westinghouse Electric Corp. is supplying propulsion equipment for five atomic submarines to be built for the U. S. Navy; the subs are: Skate, Sargo, Swordfish, Sea Dragon, and Halibut. Westinghouse is also supplying the reactor for the Halibut.

Moplen (polypropilene) is the name of a new thermo-plastic based on a discovery which permits the arrangement of molecules in a prearranged order to obtain the desired characteristics in the finished product. According to reports, no other thermo-plastic has these physical and chemical properties. Besides being the lightest of all plastics (specific gravity of 0.90), Moplen will take temperatures up to 320 F. A strip 1¼ in. wide and 0.5 mm thick supported a weight of 660 lb. Made in the Montecatini Research Laboratories, Ferrara, Italy, Moplen is made by polymerizing propilene, a gas easily obtained by oil-cracking. The plastic is made as a fine white powder, which is then processed into colored granules. It has good dielectric properties, at high frequencies, and can resist chemical and corrosive materials at high temperatures.

With its distributor rights to all Mercedes-Benz cars, Studebaker-Packard boasts a line of cars selling from $1776 (the new Scotchman Champion due this month) to $13,000 (the Mercedes-Benz 300SL roadster).

COMING EVENTS

JUNE 9-13

ASME Semi-Annual Meeting, Sheraton-Palace, San Francisco, Calif. There will be papers on: "The Mechanical Design Approach to Simplified Maintenance," "The Titanium Sheet Rolling Program," "Metals Engineering and Fabrication Aspects of High Speed Aircraft," "New Materials and Processes for the 'Hot' Airplane," "Automation and New Methods for Overhaul," etc.

JUNE 9-13

Fourth International Automation Exposition, The Coliseum, New York City. To be held with the Military Automation Exposition.

JUNE 9-14

Third Annual Automation Seminar, Pennsylvania State University, University Park, Pa. Seminar expanded this year to include automation for in-line manufacturing methods of getting parts into and out of machinery, control systems and utilization of standard components.

JUNE 14

Regional Technical Conference, Lowell Institute of Technology, Lowell, Mass. The conference will be on "Plastics for Electronics."

JUNE 16-21

Fourth Annual Seminar in Creative Engineering, Pennsylvania State University, University Park, Pa. The sessions are designed for administrators, managers, engineers, scientists, government officials, armed forces personnel, and others. Attendance will be limited to 75. For further information write to Maurice Giesdahl, professor of mechanical engineering, The Pennsylvania State University.

JUNE 17-21

65th Annual Meeting of the American Society for Engineering Education, Cornell University, Ithaca, N. Y. The agenda will include: improving high school science preparation; increasing the supply of engineering teachers for the rapidly growing enrollments, the problems of research and research manpower in engineering colleges; and more efficient use of colleges' unlimited facilities and staff. During the week there will be 130 scheduled events.

JUNE 19-21

12th Annual Meeting of the Association for Computing Machinery, at the University of Houston, Houston, Texas. For further information write to the Association at the University, Cullen Blvd., Houston 4, Texas.

JULY 1-AUGUST 30

Second Annual Summer Program in Nuclear Energy for Industry, University of Calif., Berkeley 4, Calif. This 9 week course is for engineers who need a basic knowledge and facility in nuclear engineering and in its applications to industry. An A.B.S. or A.B. in engineering or a physical science is required. Tuition is $600. A one week Nuclear Engineering survey from July 8-12 will be a lecture, demonstration and discussion course—an executive survey. Concepts will be defined and described, and their impact on finance, engineering, and economics will be discussed. Enrollment is limited to persons with executive and managerial responsibilities. Tuition for this course will be $100.

AUGUST 11-15

First National Conference on Applied Heat Transfer, Pennsylvania State University, University Park, Pa. Sponsored by the Heat Transfer Div. and the Central Pennsylvania Section of the ASME. The theme will be Applied Heat Transfer, and papers are being solicited which bear directly upon heat transfer applications. Particularly sought are papers dealing with the design, construction and use of heat exchangers, economic and practical problems associated with insulation, methods of instrumentation and tests, and the results of research which may be applied in industrial practice.

AUGUST 20-23

Western Electronic Show and Convention (Wescon), Cow Palace, San Francisco, Calif. More than 200 papers will be scheduled under general headings including: automatic control; circuit theory; component parts; electronic devices; electronic computers; engineering management; industrial electronics; instrumentation; military electronics; nuclear science; production techniques; reliability and quality control; and remote control.

AUGUST 26-28

1957 Gas Dynamics Symposium, at the Technological Institute, of Northwestern University, Evanston, Ill. The theme will be "Transport Properties in Gases at High Temperature and Pressures." One object will be to define the art in both theory and experiment for the determination of the transport properties of gases, with particular reference to extreme conditions. Present and future needs for data with respect to application and design will be indicated. For further information contact Dr. Ali B. Cambel, Gas Dynamics Lab., Northwestern Univ., Evanston, Ill.

SEPTEMBER 4-6

Special Technical Conference on Magnetic Amplifiers, Penn Sheraton Hotel, Pittsburgh, Pa. There will be five technical papers on "New Circuits and Techniques," twelve papers on "Analysis and Design," and six papers on "Applications."

SEPTEMBER 9-13

12th Annual Instrument & Automation Conference, Cleveland Public Auditorium, Cleveland, Ohio.

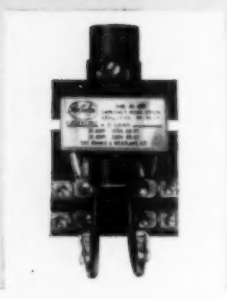
SEPTEMBER 9-13

3rd Annual Titanium Lecture program, New York University, College of Engineering. Attendance is limited. For further information write to Dr. Harold Margolin, New York Univ., Univ. Heights 53, New York, N. Y.

SEPTEMBER 24-25

6th Annual Industrial Electronics Symposium, Morrison Hotel, Chicago, Ill. Major subjects will be: Development of Transducers and Other Elements of Industrial Electronics Systems, and Integrated Systems for Industrial Electronic Control. Inquiries should be sent to E. A. Roberts, Union Thermoelectric Corp., 2001 Greenleaf St., Evanston, Ill.

When you need Reliable Control of Material Handling



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Stress-Concentration Factors—I

ALEXANDER GOMZA, *Group Leader, Grumman Aircraft Engineering Company*

SHARP discontinuities in machine parts, such as holes, notches and shoulders, form localized stress concentrations that may cause the part to rupture under load.

Fig. 1(A) shows the stress concentration around a hole in a bar under tension. Maximum tensile stress S_m at the edge of the hole is much greater than the average tensile stress S_a at points away from the hole.

The ratio of S_m to S_a is defined as the stress-concentration factor K, or $K = S_m/S_a$, where S_a is found by dividing P by the reduced cross-sectional area along section x-x.

With notched bars subjected to a bending moment M, Fig. 1(B), the stress distribution without the notches is shown by the dashed line, and the nominal stress at the base of the notch S_n is equal to Mc/I, where c is the semi-depth and I the moment of inertia of the net section. This nominal stress, however, is less than the actual stress S_m and the ratio S_m/S_n is equal to K.

For ductile materials under static loads, this stress increase is not important as it will be relieved when the metal yields. With brittle materials, however, or with materials that undergo cyclic loading, the stress concentrations may well develop cracks which will lead quickly to failure.

The charts give stress-concentration factors for various plates and bars with holes and notches. A second set of charts will be published next month.

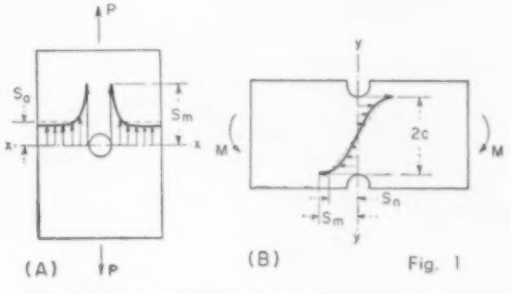


Fig. 1

Slotted bars under axial load

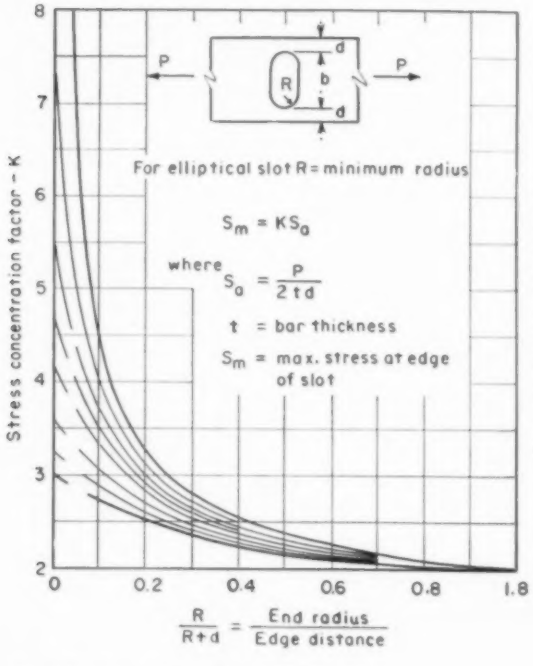
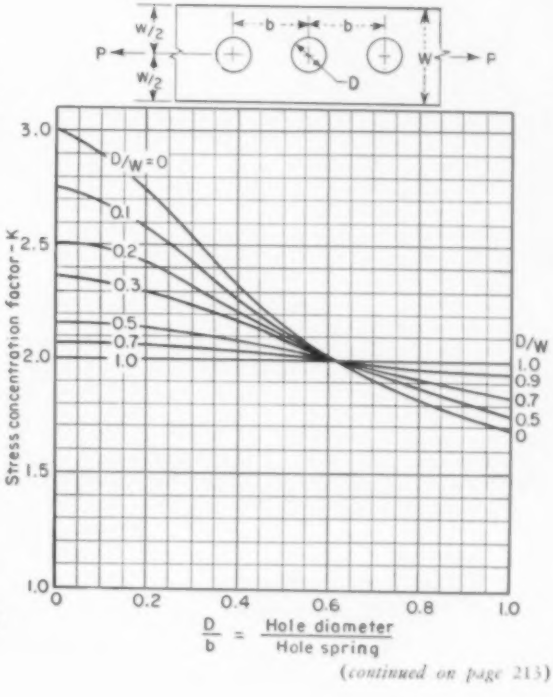


Plate under axial load with series of centrally located holes



(*continued on page 213*)

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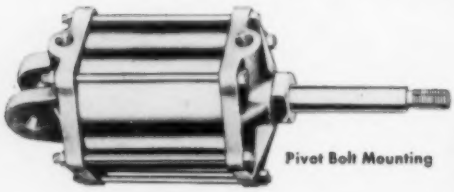
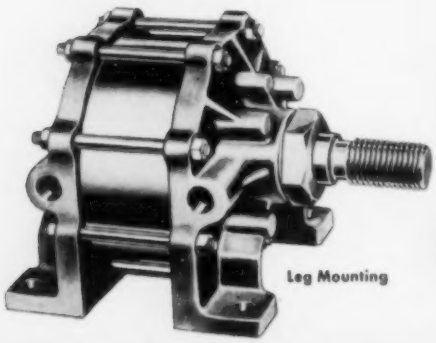
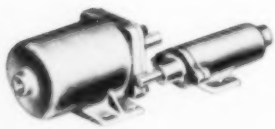


Pivot Bolt Mounting

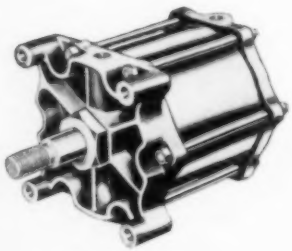


Leg Mounting

Base Mounting



Small Clamping Cylinders



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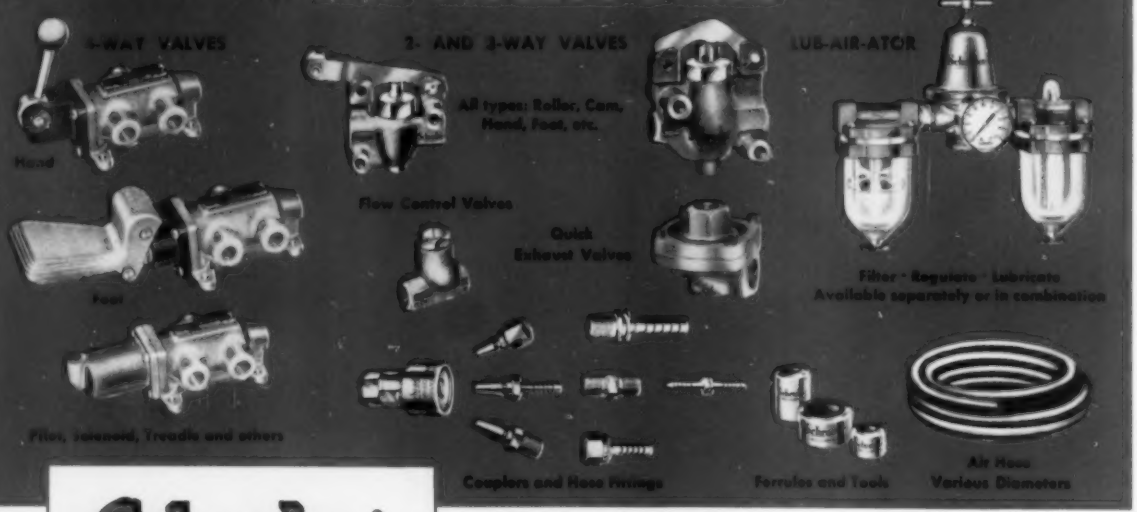

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Stress-Concentration Factors—I (continued)

Slotted bars in pure bending

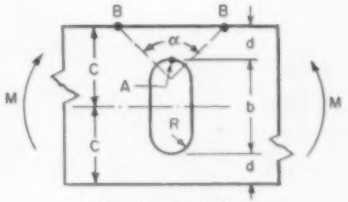
Eq. 1: $-S_A = KMc/I$ = maximum stress along edge of slot (at point "A")

Eq. 2: $-S_B = Mc/I$ = maximum outer fiber stress (at points "B" – see table)

I = Moment of inertia of net area through slot, taken about an axis through middle of bar

Note:
1. Solid lines indicate that maximum stress is at slot edge (Use equation 1 above)
2. Broken lines indicate maximum stress is at outer fiber (Use equation 2 above)

Location of points "B"	
R/b	α
0.125	70°
0.25	65°
0.50	60°



In an elliptical slot
R = minimum radius

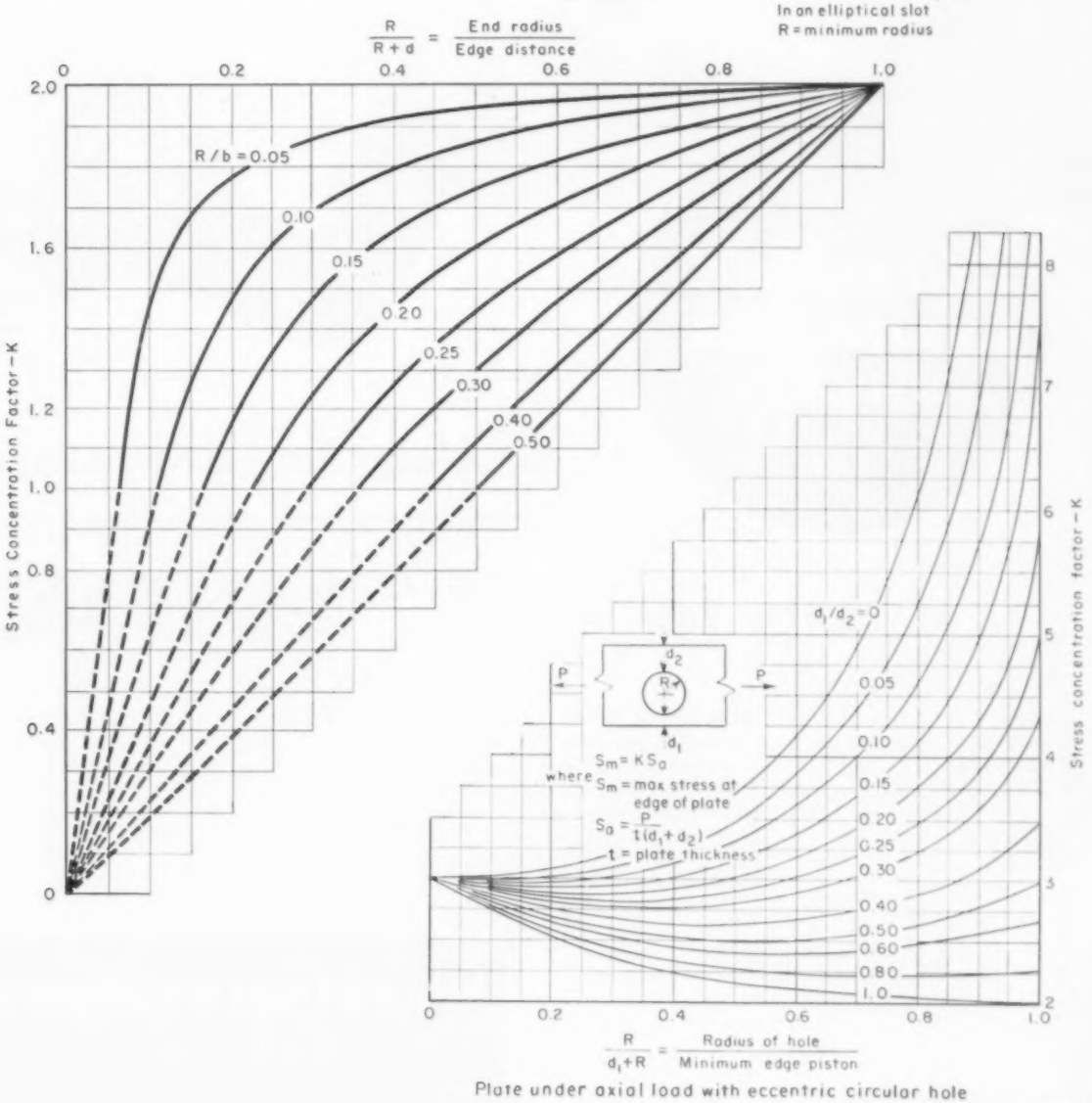


Plate under axial load with eccentric circular hole

(*continued on page 215*)

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Type 430 Bright Finish

up to 48" WIDE

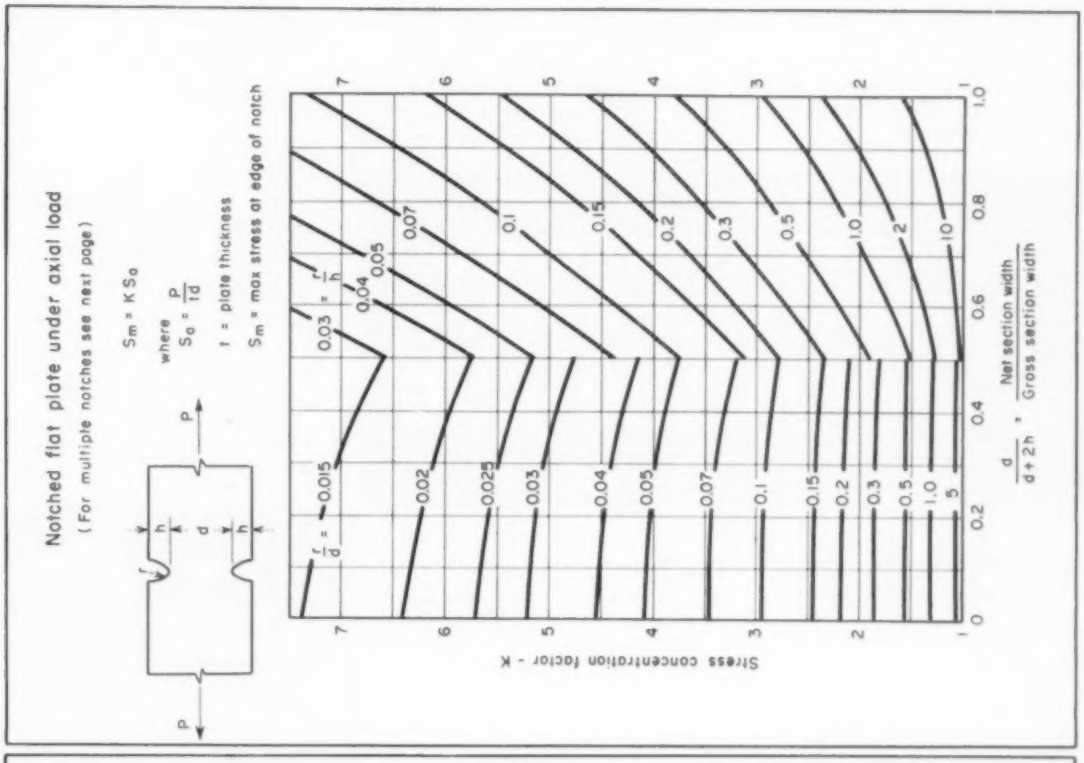
BRIGHTER THAN EVER!—MicroRold stainless steel Type 430 in the NEW Bright Finish is now immediately available in sheets up to 48" wide offering new usefulness and economy in stainless fabrication. Produced with the same micro-accuracy of gauge for which MicroRold 36" is well known, Type 430 Bright up to 48" wide gives greater latitude in applications for quality stainless steel.

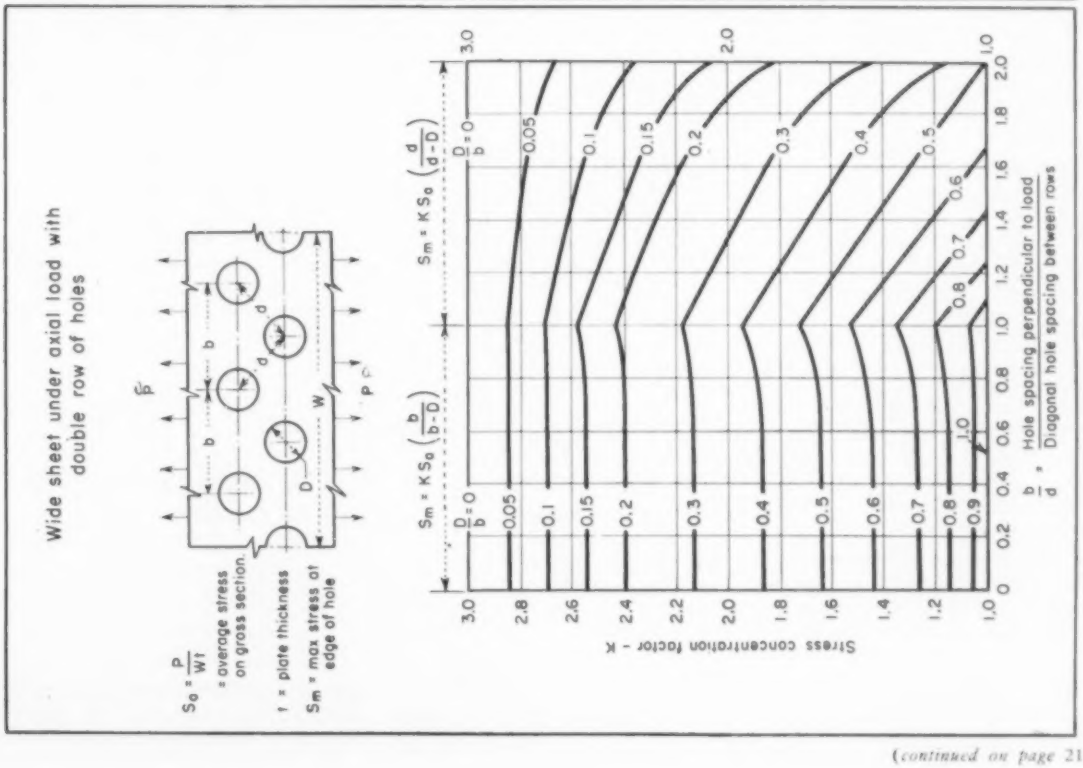
MicroRold 430 is also available in the regular commercial finishes and MicroRold stainless in other grades are now produced up to 48" wide. Complete details sent on request.

Washington Steel Corporation

6-G WOODLAND AVENUE WASHINGTON, PA

Stress-Concentration Factors—I (continued)





(continued on page 217)

Why COST CONSCIOUS men are choosing Norgren MICRO·FOG

1. Better Lubrication — Less Machine Down Time

MICRO-FOG lubrication automatically coats all the bearings, gears, chains and other components of a machine with a continuous, protective film of clean oil. Just the right amount of oil is applied to provide the most efficient lubrication, reducing wear on machine components and cutting maintenance and replacements costs.

2. Oil Always Fresh, Always Clean

There is no recirculation of deteriorated or contaminated lubricant to cause wear or corrosion. Clean oil is applied continuously to all lubrication points in carefully metered amounts.

3. For Large and Small, Plain and Anti-Friction Bearings

MICRO-FOG Lubricating systems have found enthusiastic acceptance for use on all types of machinery, ranging from *high speed* grinders to huge roll mill bearings on shafts as large as 34" in diameter and turning at relatively *low speeds*.

4. Centralized, Automatic Lubrication

A single, MICRO-FOG Lubricator will automatically deliver enough airborne lubricant, proportionately distributed to completely lubricate even a large machine tool. Only one lubricator to maintain and refill.

5. Big Savings in Lubricant

Carefully metered quantities of oil are applied to each lubrication point. MICRO-FOG provides more thorough lubrication using only a few ounces of oil per day than other methods using several gallons of oil per day.

6. Bearings Run Cooler

Air passing through the bearing carries away heat, and there is no pool of lubricant in the bearing to generate heat as a result of fluid friction. Lubrication is continuous — there are no periods of insufficient lubrication with metal wearing on metal.

For Lubricating

- BEARINGS
- GEARS
- CHAINS
- SLIDES
- WAYS
- OTHER MACHINE COMPONENTS

7. Contaminants Excluded From Bearings

A slight positive pressure is maintained within the bearing, and air continuously escapes from the bearing, preventing the entrance of contaminants from the surrounding atmosphere.

8. Fewer Bearing Seals Required

Because MICRO-FOG must be vented to the atmosphere, it is not necessary to maintain tight seals. Fewer oil seals are required, reducing maintenance and machine down-time.

9. Oil Filters, Sumps and Pumps Eliminated

The quantity of lubricant used in MICRO-FOG Lubrication System is so small that there is nothing to reclaim or recirculate. Expensive high pressure piping is also eliminated.

10. Automatic Alarm Controls

MICRO-FOG Lubricators are available with switches to actuate an alarm system or controls as a warning of conditions affecting proper lubrication.

11. Visible Oil Feed

The oil feed is readily visible on all models of MICRO-FOG Lubricators, providing positive proof that the lubricator is operating properly.

12. A MICRO-FOG Lubricator For Every Size Machine

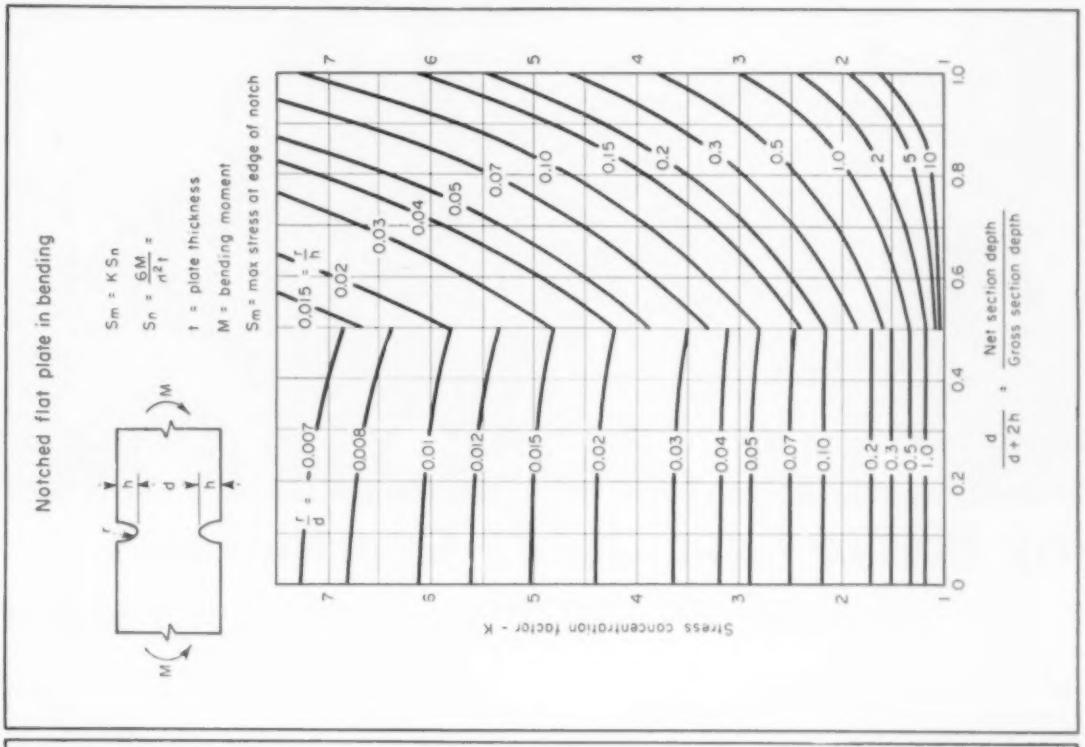
19 models to choose from—ratings up to 1,000 bearing inches and oil reservoir capacities up to 4½ gallons.

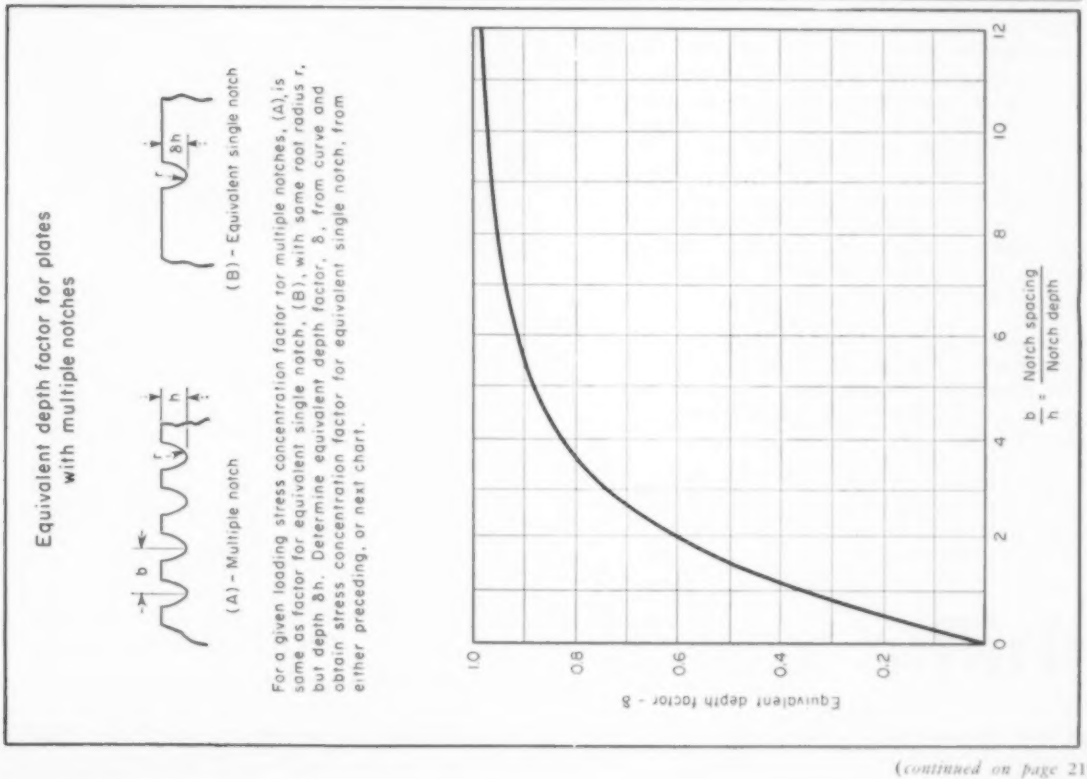
For complete information, call your nearby Norgren Representative, or WRITE FOR NEW 800 CATALOG.

C. A. NORGREN CO.

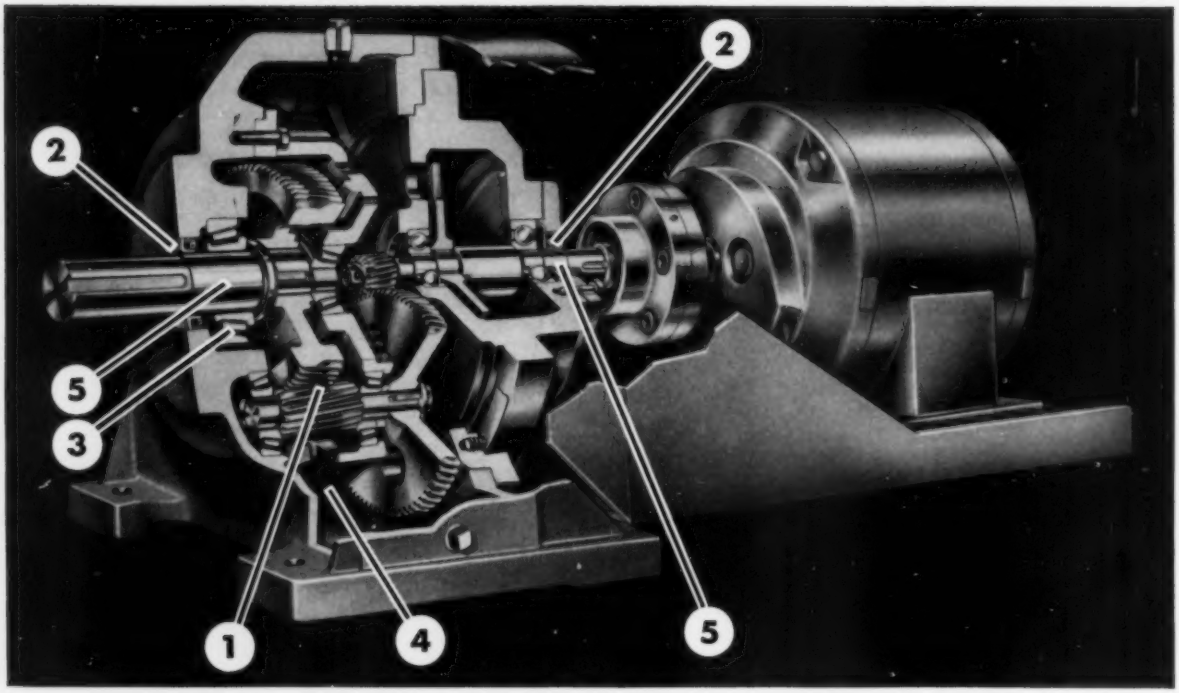
3428 SO. ELATI ST., ENGLEWOOD, COLORADO

Stress-Concentration Factors—I (continued)




Equivalent depth factor for plates with multiple notches
(A) - Multiple notch
(B) - Equivalent single notch
For a given loading stress concentration factor for multiple notches, (A), is same as factor for equivalent single notch, (B), with same root radius r, but depth δh. Determine equivalent depth factor, δ, from curve and obtain stress concentration factor for equivalent single notch, from either preceding, or next chart.
Equivalent depth factor - δ
b/h = Notch spacing / Notch depth

(continued on page 219)

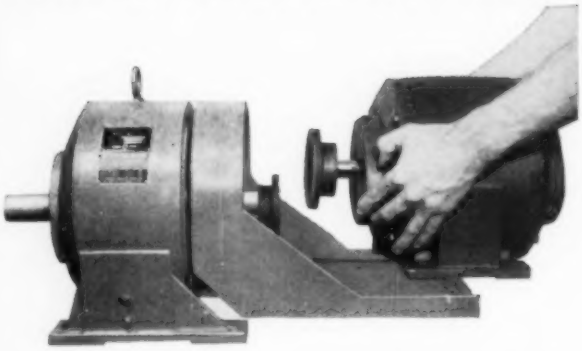


Why Phillie Gear Utility GearMotoRs reduce downtime...motor inventory

The new Philadelphia Utility GearMotoR has already won wide acceptance among plant engineers and designers, because: any standard NEMA foot-mounted motor can be used . . . *without special modifications for shaft, flange or supporting devices.* Here is a packaged power drive, ideal for use where flange-mounted motors are a supply problem. You can utilize readily available or existing foot-mounted motors immediately, because of the integral motor mounting base. This new Utility GearMotoR substantially reduces machinery downtime for motor changeover or replacement. Simply remove bolts securing motor feet, separate shaft coupling . . . lift motor off . . . and replace . . . all in a few minutes.

Steel motor support is rigidly ribbed to maintain shaft alignment, precision-drilled to receive NEMA motor frame mountings. Save time and money all around. Specify the Philadelphia Utility GearMotoR.

Send for Catalog GM-560 which fully describes and illustrates the new Philadelphia GearMotoRs, Utility GearMotoRs, In-Line Reducers and Motorized Worm Gear Drives.



1. HELICAL GEARING assures silent operation, increased strength, longer life and minimum friction loss. Teeth are crowned shaved and induction hardened for optimum performance.

2. TWO-WAY SEALS lock oil in, and seal dirt out.

3. OVERSIZE THRUST BEARINGS handle big overhung loads.

4. OIL BATH LUBRICATION keeps gears and bearings continually showered with clean oil.

5. HEAVY SHAFTING, heat treated alloy steel, eliminates possibility of bending or twisting under heavy loads.

phillie gear®

PHILADELPHIA GEAR WORKS, INC.

ERIE AVE. & G STREET, PHILADELPHIA 34, PENNA.

Offices In all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS

Virginia Gear & Machine Corp. • Lynchburg, Va.

Stress-Concentration Factors—I (continued)

Maximum bending stresses in curved beams

$S_m = KS_n$

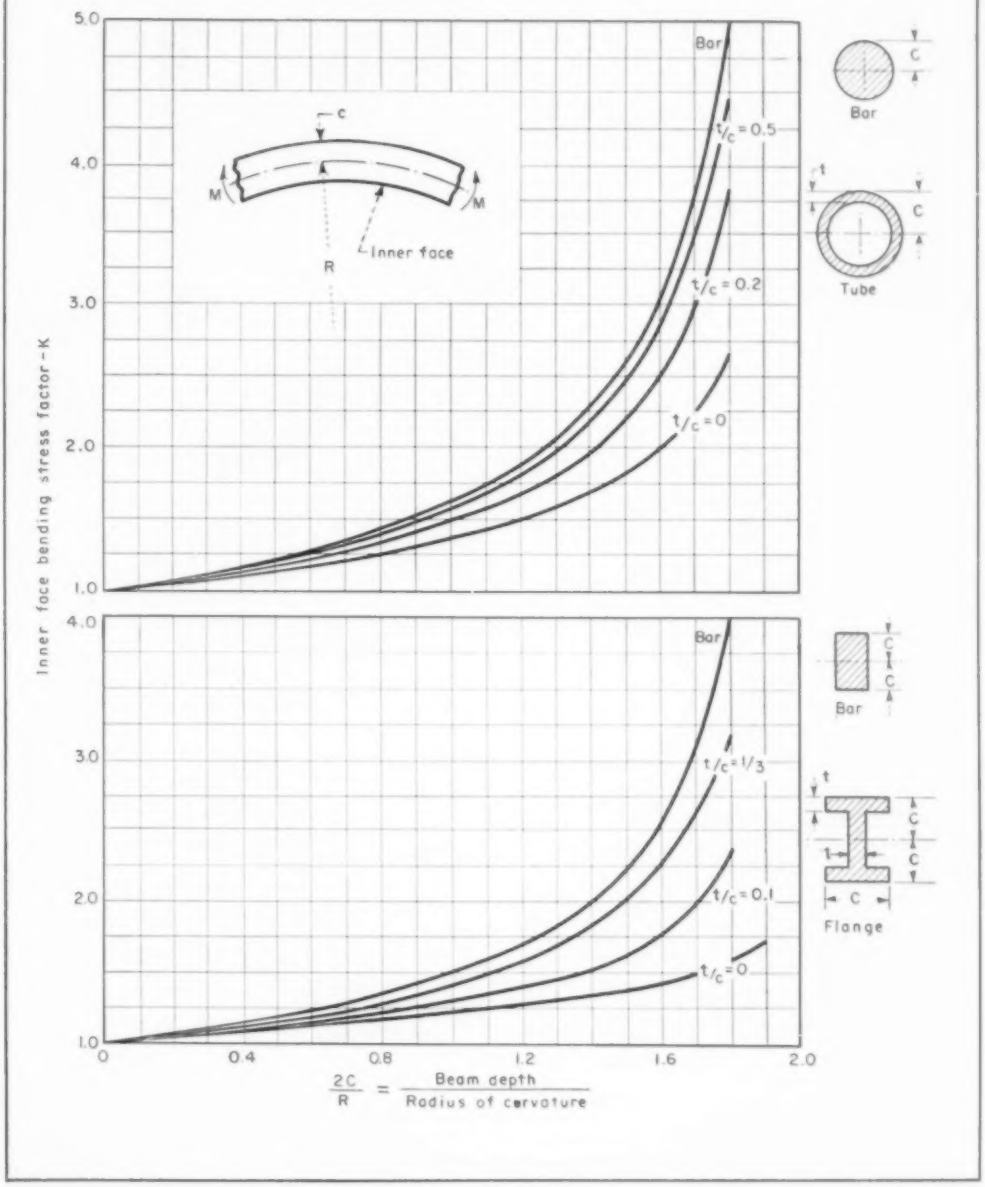
$S_n = \frac{Mc}{I}$

where

M = bending moment

I = moment of inertia

S_m = max bending stress in beam inner space



Chromium-steel Bolts With 170,000 psi Tensile at 900 F

Bolts made of 5% chromium hot-worked die steel have a 900 F tensile strength of 170,000 psi, min. This is reported to be as much as 50% greater than stainless steel and alloy steel bolts normally used at this temperature. These fasteners are expected to find applications where high temperatures are combined with high pressures and/or loads.

Initial fastener in the series is a 12-point external wrenching type of aircraft tension bolt for airframe applications. Diameter sizes will range from ¼ to 1½ in. Almost any type of fastener or related threaded part, for either tension or shear load applications, should be possible, however.

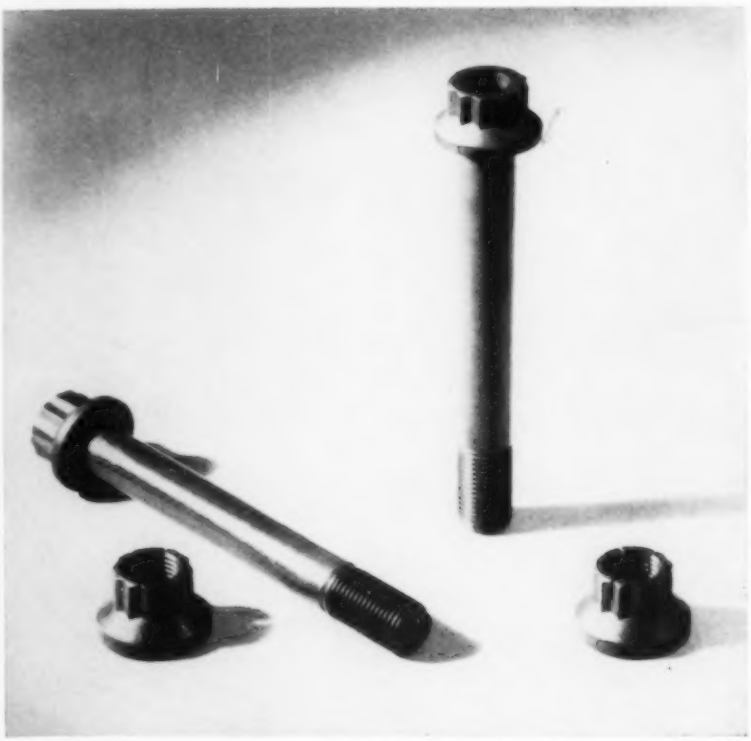
Static physical properties show proportionately low loss of initial tensile strength at temperature, also unusually high stability of bolt material after soak at temperature.

Almost all of initial room temperature tensile strength is retained after 100-hr soak at 900 F. The new bolt's 220,000 psi min tensile at room temperature is reportedly as high as any fastener in production. With a room temperature shear strength of 140,000 psi, the bolt retains a minimum of 100,000 psi at 900 F. Fatigue tests were of tension-tension type with load alternating between maximum and 10% of maximum. Endurance strength of bolts tested at 900 F equalled that of bolts tested at room temperature.

The larger-than-normal root radius of the bolt reduces stress concentration at the weakest point, and increases cross-section area slightly.

The fastener's diffused nickel-cadmium plating is deposited as separate layers of nickel and cadmium. Thermal treatment diffuses the two into a corrosion and oxidation-resistant alloy good up to 1000 F. Standard Pressed Steel Co., Jenkintown, Pa.

For more information—
Circle 1, inside back cover



Properties of 5% Chromium Hot-work Steel Bolt

	Room Temperature	Tested at Room Temp after 100-hr Soak 900 F	Tested 900 F
Ultimate tensile, psi min	220,000	220,000	170,000
Yield Strength, psi min	185,000	185,000	140,000
Elongation in 4 diameters, % min	10	10	16
Reduction of area, % min	35	35	50
Shear Strength, psi min	140,000	140,000	100,000
Stress Rupture, psi for 100 hr life	.....	.....	130,000
Fatigue Strength, psi at 8 million cycles, 10% pre-load	80,000	55,000	80,000
mpact Strength, ft-lb (Charpy)	18	18	23

Small, Low-Voltage D-c Motors

For electrical actuation of motor vehicle components, a variety of low-voltage, d-c motors has been designed with frames as small as 2 in. dia. They are also said to be finding application wherever low-voltage (6, 12, 24 or 32 v) current is available.

A typical example of this possibility is a 3 in. cranking motor for outboard marine engines. Another type, 2¾ in. dia, powers small winches.

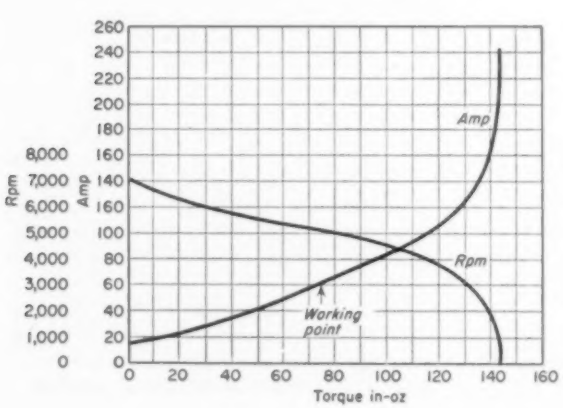
In some applications, a simple two-pole, series wound, uni-directional motor is adequate. In others it may be necessary to employ two or even four-pole designs that are reversible. The design depends on what the end use requires to be emphasized, whether it be high torque, ability to operate under load for long periods of time, or other particular characteristics.

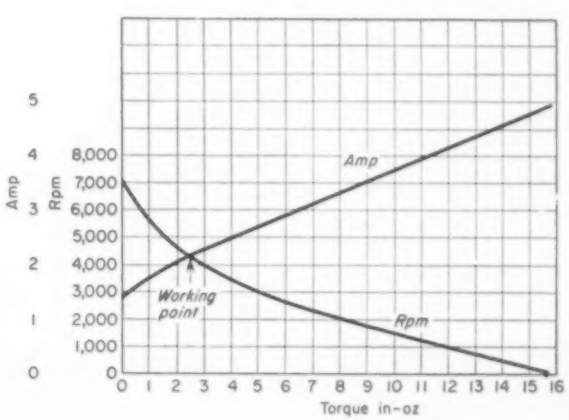
For example, a 2¾ in. motor often subjected to continuous duty might develop 0.015 hp. If intended for service where it will operate only 2% of the time, it might be designed to develop 0.3 hp. For still shorter periods of service, it could be designed to develop 0.53 hp.

These motors are not stock items (except for service replacement) and the various types are designed for volume production for specific applications. As far as specifications are concerned, outside of the minimum 2 in. dia, everything else can and does vary according to the design. The physical length varies. The power output ranges from types that crank medium size gasoline engines down to one that may only open the flap in a heater.

As to wiring diagrams, these naturally vary according to the type of winding or combination of windings, whether the motor is uni-directional or reversible, etc. according to standard electrical design. American Bosch, Div. American Bosch Arma Corp., Springfield 7, Mass.

For more information—
Circle 2, inside back cover





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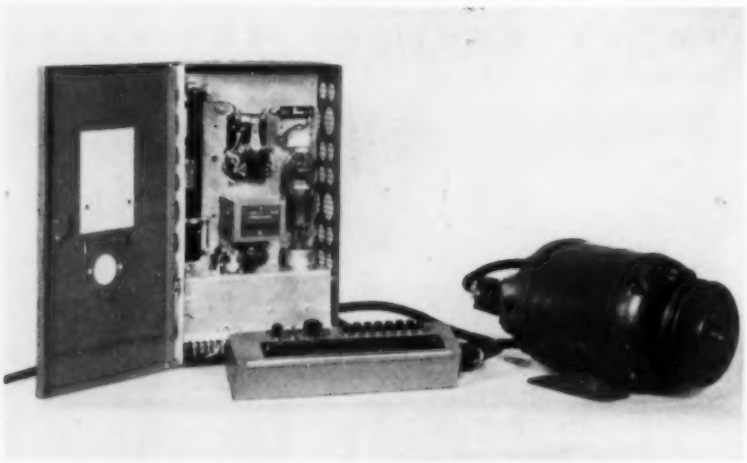


Adjustable Electronic Motor Drive

The power unit in this control is designed to govern motors of various manufacturers, for operation from either 115 or 230-v sources. Operating from half-wave rectified a-c, a single thyratron is used without an anode transformer.

The speed programming is accomplished by a specially designed selector, which permits the operator to change from one speed to any of several other pre-selected speeds, either forward or reverse, without over-shoot or under-shoot and without coming to a stop. This control station may be manually operated by pushbuttons or designed for automatic selection up to 16 pre-selected speeds.

For inching or positioning a jog button is provided and where motor speeds outside the program are required a potentiometer is supplied, for adjustment over a 35:1 ratio. Dynamic braking is also provided. VeeTrol Engineering, Inc., P. O. Box 1089, Stamford, Conn.

For more information—
Circle 3, inside back cover

Plug-In Hydraulic Pressure Gage

When the engineer, service or maintenance man desires to check a pressure, cap is removed from the valve-sealed tap with a wrench, and the adapter attached to the gage is inserted. Tightening down the union nut opens the valve, and the gage registers system pressure. When the nut is loosened and the gage removed the valve closes automatically.

The system is expected to prove especially suitable for locations where permanent gage installations are generally omitted because of impracticability due to hydraulic shock, mechanical vibrations, and possible damage due to external causes. Maximum working pressure is 3000 psi. Made of steel, cadmium plated, with seals for hydraulic service standard. Seals for other fluids available. Republic Mfg. Co., 15655 Brookpark Road, Cleveland 11, Ohio.

For more information—
Circle 4, inside back cover

Reinforced Flexible Plastic Tubing

This tubing is a combination of plastic materials laminated together which is said to provide a greater tensile strength to weight ratio. It was designed for use as a ducting to convey liquids, gases or air under pressure; as ducting to convey corrosive acids and alkalis; and as a non-magnetic insulating and dielectric flex conduit for electronic and electrical applications. Watts are 0.045 in. in thickness and are smooth inside and out.

The tubing is available in $\frac{1}{8}$ to 4 in. ID is $\frac{1}{8}$ in. increments, and up to 10 ft long. Weight is 0.07 lb/in. ID/ft of length. Burst pressure is 70 psi min. Airconductors, 1458 W. Compton Blvd., Compton 3, Calif.

For more information—
Circle 5, inside back cover

Hydraulic Pump for 5000 Psi Systems

Aircraft hydraulic systems requiring 5000 psi have previously only been available in industrial equipment. Pumps with steel or cast iron housings and covers were used. A new pump is said to have operated successfully for over 1000 hr at 5000 psi.

The pump delivers approximately 7.5 gpm at 3750 rpm and in weight is within $\frac{1}{4}$ lb of a standard pump rated for this flow at 3000 psi. Appli-

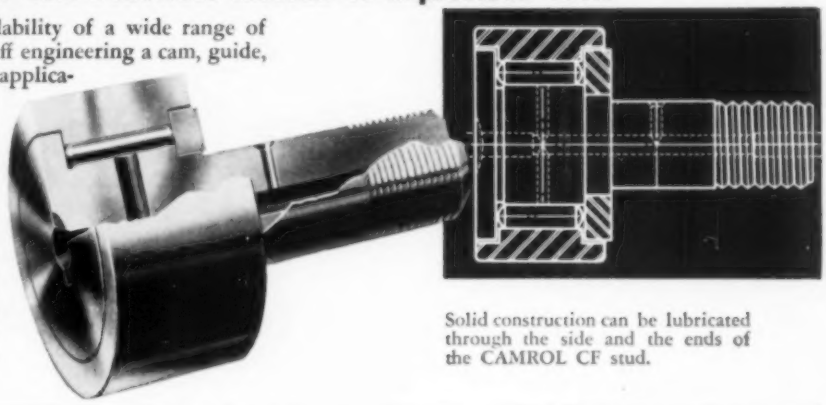
CONTINUED ON PAGE 224

BEARING TIPS by McGill

For convenience, with savings in time and cost

Use McGILL® CAMROL Cam Followers instead of improvised units

Simplification of design with availability of a wide range of standard bearings takes the strain off engineering a cam, guide, support or track roller bearing application. No need to "build up" a special unit when you can select the proper size standard CAMROL bearing engineered especially for the job. McGill's CAMROL bearing construction offers full type capacity, with provision for shock, in a compact precision unit. Specify CAMROL, the original cam follower, in either CF (with stud) or CYR (shaft mounting) series. Sealed and prelubricated bearing available also.



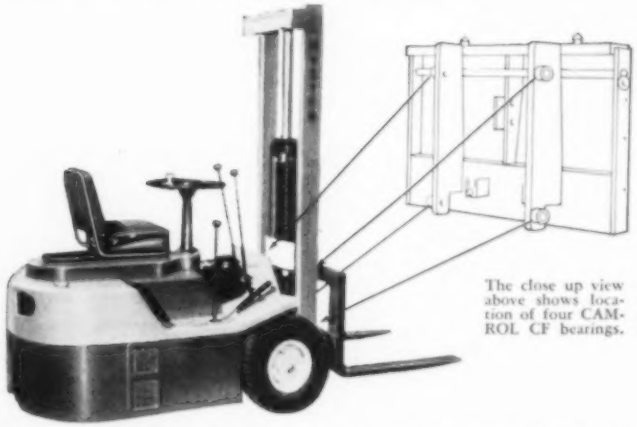
Solid construction can be lubricated through the side and the ends of the CAMROL CF stud.

YR bearings help F-100 Super Sabre make slower and safer landing

The supersonic speeds obtained by today's modern aircraft set up design problems not encountered with older, slower planes. The overall streamlined design required for speed in flight, for instance, necessitated finding ways of supporting the North American F-100 Super Sabre at low air speeds required for landing. A

series of slats on the leading edge of the wing, providing greater lift at lower air speed, was the answer. Each slat is supported by McGill CAMROL YR bearings — especially designed to permit shaft or yoke mounting. These long-life bearings carry the loads of these slats as they move on tracks during flight of the Supersonic F-100.

CAMROL CF bearings out-perform friction rollers as fork support bearings



The close up view above shows location of four CAMROL CF bearings.

Small size and high load-carrying unit construction with simplified lubrication are among principal benefits obtained by Hyster Company from use of CAMROL CF bearings as fork support rollers in its Hyster 20 and other lift trucks.

Two bearings ride up and down inside each vertical mast section to position the lift truck fork under load. Speeds are relatively slow but the crushing loads on each bearing are heavy.

In this particular application, the exterior surfaces of the bearings are treated with a black oxide finish. This provides corrosion-resistance which serves to augment maintenance-free operation, a characteristic of CAMROL bearing construction.

Fact-packed Bearing Catalog

Write for your copy of Catalog 52-A, a revised, 128-page Bearing Selection Guide.

Insure performance with McGILL®

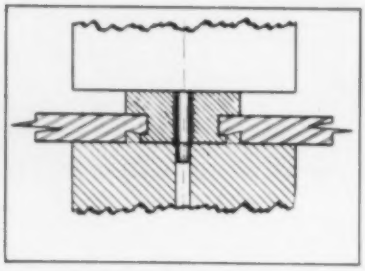
MULTIROL® GUIDEROL® CAMROL
Precision Needle Bearings

McGILL MANUFACTURING COMPANY, INC., 201 N. LAFAYETTE ST., VALPARAISO, INDIANA

USING

cations for this high pressure pump should be within the normal operating range of 3000 to 3750 rpm. New York Air Brake Co., Watertown, N. Y.

For more information—
Circle 6, inside back cover



Staked Fastener

These fasteners are said to provide load-bearing threads in sheet material such as aluminum, brass, steel and copper. A shoulder design for maximum strength is available for panels. 0.031 to 0.250 in. thick. Flush types for minimum space fit panels 0.064 to 0.250 in. thick. My-T-Grip Mfg. Co., 176 Broadway, New York, N. Y.

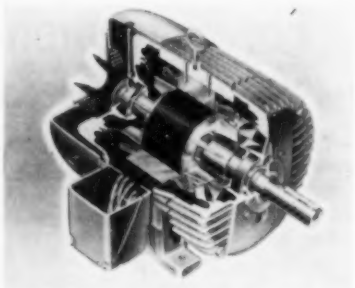
For more information—
Circle 7, inside back cover

A-c Induction Motors 40 to 125 Hp

Both open-dripproof and totally-enclosed fan-cooled motors are built to NEMA standards MG1-3.02.a, MG1-5.05.b and MG1-5.02.d. Weight reduction, compared with the former line, is said to average 20%. Lineal dimensions have been reduced an average of 10% and volume an average of 27%. The weight and space savings have been achieved largely as a result of insulation improvements. The Class A system includes slot cell insulation with double-backed polyester providing greater physical and dielectric strength. Top sticks are made of non-hydroscopic glass with improved dielectric strength and higher heat resistance. The entire electrical system is designed to have a corona starting voltage well above operating voltage.

Wire for stator windings is shaved after drawing to provide maximum smoothness of the wire surface and to reduce chances of tiny barbs piercing the insulation. The windings are varnish-coated.

Glass-cloth phase strips are used on two-pole motors, reducing the problem of loose wires and wire fatigue. The entire pre-wound stator is given final treatment with silicone varnish.



Stator laminations of high quality silicon steel are automatically welded by the gas-shielded process. An iron oxide coating insulates each punching for reduction of eddy current, and the punchings are further protected with a varnish that maintains its insulating properties even when exposed to molten aluminum.

Centrifugal casting reduces porosity of the aluminum conductor in the rotor. Rotor slots have been completely closed to reduce motor noise. Air passages have also been designed for noise reduction, and panels are non-resonating. Every motor is given a series of automatic tests for noise,

Drafting Table-Desk Combination

Drafting tables that provide space for working, storing drawings and filing correspondence and blueprints have an overall size of 106 x 36 in. deep. Working space on the adjustable-angle drawing board is 60 x 36 in. deep, and on the attached reference table 48 x 33 in. deep. Full-size drawings can be stored in the 37 x 27 x 2 in. drawer under the reference table top.

The base of the drawing table provides filing space in a box drawer and two standard size filing cabinet drawers. The draftsman has a foot rest under the 36-in. high drawing board. Republic Steel Corp., Berger Div., Canton 5, Ohio.

For more information—
Circle 8, inside back cover

CONTINUED ON PAGE 226

USING

DU PONT ELASTOMERS

neoprene · Hypalon®

in design

"Non-skid" neoprene reels help dye slippery synthetic fabrics

Gaskets of HYPALON unaffected by 2% ozone after two years' use

For two years, a large chemical firm has used gaskets of HYPALON in its ozone generators. Despite constant exposure to 2% ozone, not one gasket failed because of ozone cracking.

The ozonator is a steel shell packed with glass tubes. As dry oxygen passes through the tubes, it is converted to ozone by high-voltage electrical discharge. Each end of the shell is closed by a dished head sealed with a gasket of HYPALON.

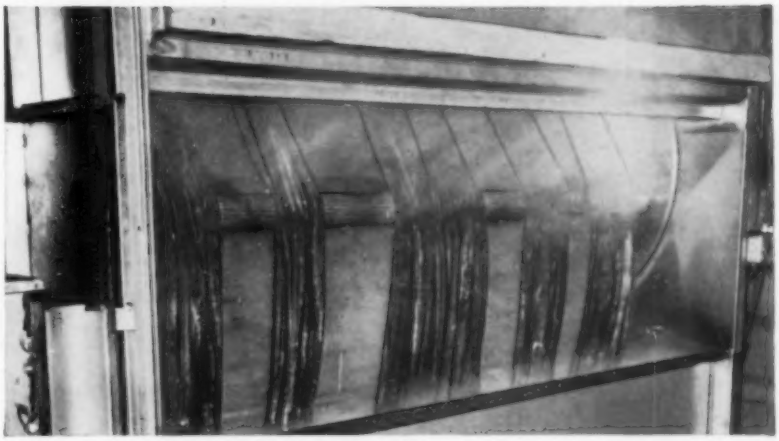
Plastic gaskets too rigid

Plastic gaskets, which were formerly used in the generators, were unaffected by ozone, but took a permanent set under flange pressure. When a head was removed for routine maintenance the plastic gasket was too distorted to put back. Gaskets of HYPALON are reused.

Designing with HYPALON

HYPALON offers many additional advantages compared to other types of rubber. It resists strong oxidizing acids; can operate at temperatures from 250° F. to 350° F.; resists weather and sunlight. This Du Pont synthetic rubber can also be compounded in an unlimited range of stable colors. HYPALON offers extra long life and lower operating costs in jobs where conditions are severe. Just mail coupon for full information.

Gaskets made of HYPALON seal each end of this ozonator; they show no deterioration after two years in service.



Fluted neoprene bars show little wear after four years in dye machine. Dye bath may be acid or alkaline, oxidizing or reducing. Temperature is 200° F.

Mill uses neoprene to get needed traction for hauling fabric through dye bath

Chatham Manufacturing Co., of Elkin, N. C., used neoprene to solve an unusual problem in dyeing synthetic fibers. Long loops of the fabrics are dyed in stainless steel piece dyeing machines. Loops, often 100′ long, are pulled through the dye bath by means of a reel. The slow rotation of the reel assures even dyeing over the full length of the goods.

The progress of the fabric depends entirely on friction between reel and loop. When several types of metal reels failed to produce enough friction to pull the smooth synthetic fabrics through the bath, Chatham designed special fluted neoprene bars for the reels. They provided adequate traction and ended the problem of slippage and uneven dyeing.

Chemical resistance important

Bars covered with natural rubber could have solved the traction problem but neoprene was chosen for its excellent chemical resistance. In dyeing various fabrics the dye bath may be acid or alkaline, oxidizing or reducing. Each dyeing cycle requires 3-5 hours at 200° F., and the dye machines operate 24 hours a day. Ordinary rubber just couldn't stand this treatment. Chatham's Superintendent of Dyeing, Mr. V. Caton, reports that neoprene has given excellent service for four years with little wear.

Neoprene's resistance to chemicals, heat and abrasion means long-term wear—and economy in many types of service. Mail coupon below for full details on how neoprene can work for you.

DU PONT

HYPALON *is a registered trademark of E. I. du Pont de Nemours & Co. (Inc).*

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

☐ I am particularly interested in _____

☐ Please add my name to the mailing list for your free publication, the ELASTOMERS NOTEBOOK.

E. I. du Pont de Nemours & Co. (Inc.)
Elastomer Chemicals Dept. PE-6
Wilmington 98, Delaware

Name _____
Firm _____
Address _____
City _____ State _____

vibration and insulation.

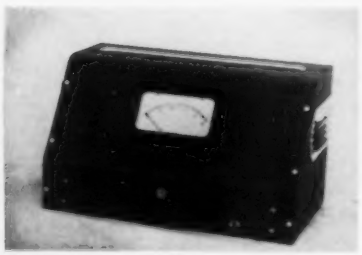
An enclosed cast iron sealed bearing housing in the end-shield is designed to hold an optimum amount of grease. The larger capacity can use the new-type synthesized grease with a controlled bleeding rate. Drain plugs, ⅛ to ½ in. larger than formerly, provide better drain and grease relief. In the open-dripproof design the one-piece cast iron frame has a larger area enclosed than formerly. The motor can thus be used in many applications which before required a splash-proof design.

Double-end ventilation eliminates hot spots associated with straight-through ventilation. Air is drawn in under both endshields, over the stator windings, and out the protected air exhausts on both sides of the frame.

All seals have one-piece cast iron frame and endshields with a 20G shock rating. Knock-off lugs, four on each endshield, make the motor easier to disassemble.

The totally-enclosed fan-cooled model has maximum protection in chemical and other corrosive atmospheres. Gaskets are used between the conduit box and frame and between the two diagonally split sections of the conduit box. The fan drives air over the motor at high velocity and pressure, and heavier ribs provide surface cooling. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 9, inside back cover

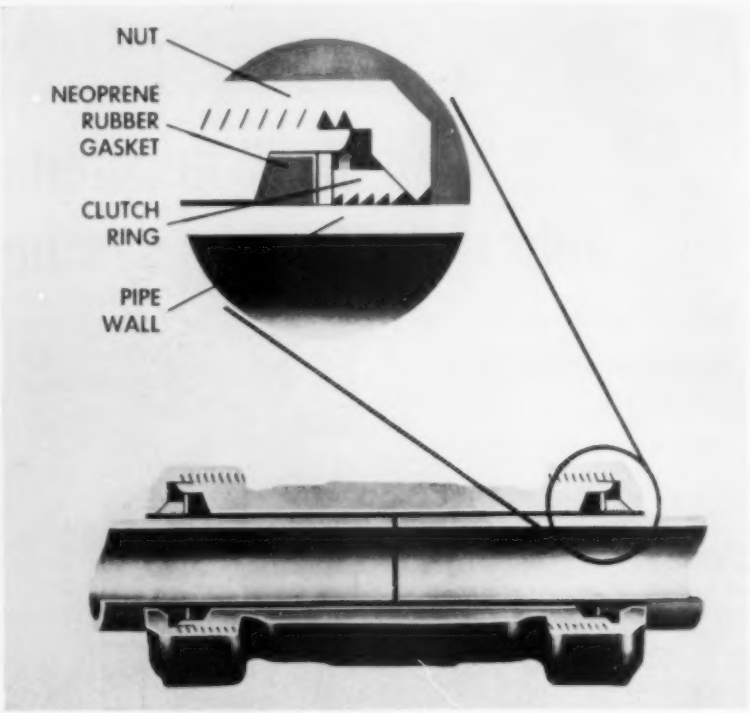


Rate-of-Change Voltmeter

A sample of the voltage received at the instrument is stored for one-half a revolution of a record-carrying disc, at which time the device compares the sample with a subsequent sample and furnishes a direct scale reading in terms of rate of change. Time intervals are variable. A typical change from 14.000 to 13.997 v, representing only 0.02% of total initial voltage can be sensed by the device.

The voltmeter measures 14⅛ x 8¼ x 8 in. high, and operates on 115 v, 60 cps current. Miljan, Inc., Paramount, Calif.

For more information—
Circle 10, inside back cover



Threadless Pipe Fittings

These fittings are said to withstand traction forces up to 3600 lb and hydrostatic pressures ranging from 450 psi on 2 in. pipe to 5000 psi on ½ in. pipe. They can be used for joining steel, wrought iron, or plastic. No threading, grooving, flaring, soldering or welding is necessary.

Gripping action is achieved through a brass clutch ring with internal serrations, which grips the pipe wall as the fitting nut is tightened. At the same time, a neoprene gasket is compressed against the pipe wall. A permanent seal and resistance to abnormal vibration, contraction or expansion is obtained. Socket ends and nuts are reamed slightly oversize to take out-of-round and off-tolerance pipe ends.

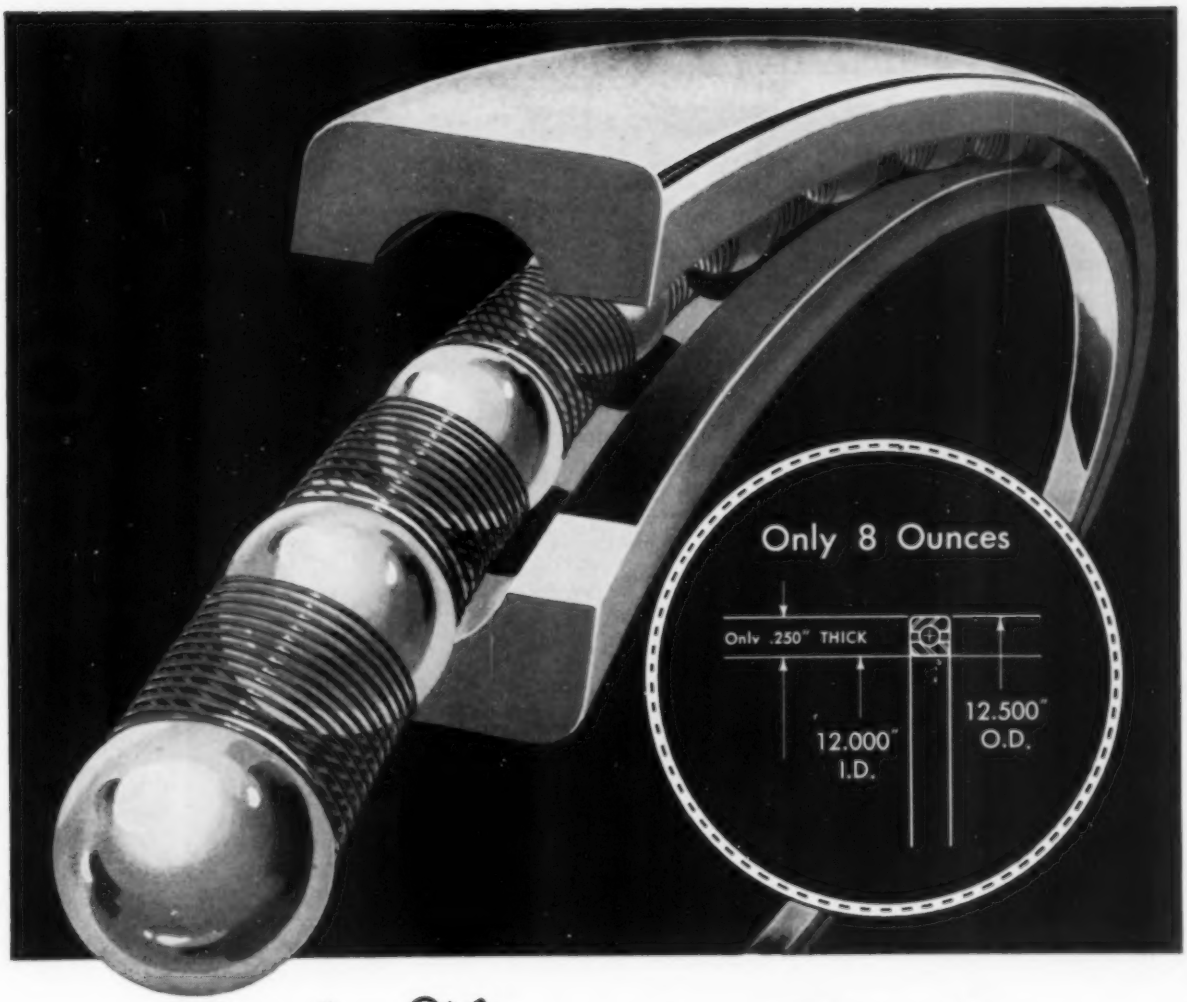
Fittings are available in couplings, adapters, 90° elbows and tees, and are made from malleable iron to ASTM specifications. They are available in galvanized or Parkerized finish. Telsco Fittings Div., 5422 Redfield St., Dallas, Texas.

For more information—
Circle 11, inside back cover

Automatic Chart Reader

The basic unit moves a chart at a uniform rate, senses the position of the inked trace on the chart, and produces an output proportional to the ordinate value of the trace. Output is presented in the form of varying voltage, shaft rotation, changing digital numbers, or as a pulse-width modulated carrier.

—CONTINUED ON PAGE 228



Reali-Slim... by Kaydon
world's thinnest radial ball bearing

HERE'S a typical example of Kaydon's *Reali-Slim* unique radial ball bearing that's finding wide application in practically every industry. *Reali-Slim* are the world's finest thin-section bearings and proportionately are thinner than a wedding ring. The bearing illustrated here is 12.000" I.D., 12.500" O.D., .250" thick — weighs less than 8 ounces. Designed for minimum weight and space limitations, it has a static load capacity of 5,520 lbs. and 894 lbs. at 100 rpm.

If you're looking for *Reali-Slim*, lightweight, radial ball or roller bearings, look at Kaydon's *Reali-Slim* line. Besides hundreds of standard *Reali-Slim* designs, there's a wide variety of special races, seals and separators to meet special bearing problems. What's more Kaydon is able to produce these *Reali-Slim*, high-precision bearings because Kaydon specializes in the unusual. In addition, Kaydon bearing engineers are prepared to give you valuable help with technical bearing application problems.

For complete data on *Reali-Slim* bearings for standard or special applications, ask for engineering Catalog No. 54RS-2.

***Reali-Slim* Ball Bearings** — in Conrad, angular contact, 4-point contact and other types are available in seven standard cross sections from .250" to 1" and in bore diameters from 4" to 40".

***Reali-Slim* Roller Bearings** — in radial or taper roller types are available in cross sections from 5/16" and in bore diameters from 5" to 40".

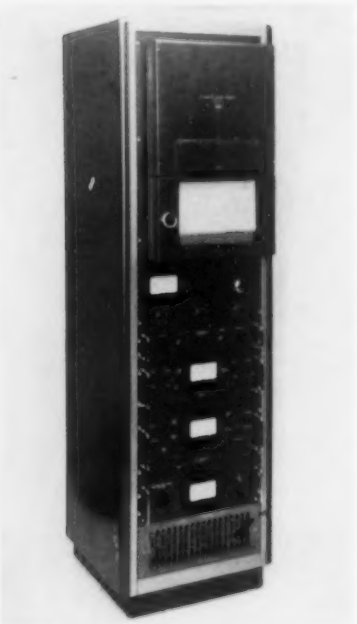
K-254

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

All types of ball and roller bearings — 4" bore to 120" outside diameter . . .

Taper Roller • Roller Thrust • Roller Radial • Bi-Angular Roller • Spherical Roller • Ball Radial • Ball Thrust Bearings



The present reader is designed to read standard charts from null-balance recorders. Changes to adapt the unit for other charts and other functions of the trace ordinate will be available. Reading accuracy is ±0.1% of the full scale. Geotechnical Corp., 3712 Haggar Dr., Dallas 9, Texas.

For more information—
Circle 12, inside back cover

ENGINEERING MATERIALS

Pipe and Block Insulation for 1200 F

Pipe and block insulation for temperatures up to 1200 F is a hydrous calcium silicate compound, blended with other selected inorganic ingredients reinforced with asbestos fibers. It is a molded insulation and is chemically converted. It is nonflammable and unaffected by water or excessive water vapor.

Pipe insulation is available in all pipe sizes up to 18 in. For larger pipe sizes, the insulation is supplied in segmental form. Block insulation is supplied in 18 or 36 in. lengths, with thicknesses of 1 or 1½ in. for 6 in. wide blocks, and with thicknesses of 1½, 2, 2½, and 3 in. for 6 or 12 in. widths. Ehret Magnesia Mfg. Co., Valley Forge, Pa.

For more information—
Circle 13, inside back cover

Titanium Wire Cloth

Rem-Cru A-40 alloy is used for 30 x 30 mesh, made of 0.016 in. wire and 10 x 10 mesh with wire 0.035 in. dia. Cambridge Wire Cloth Co., Cambridge, Md.

For more information—
Circle 14, inside back cover

Adhesive Felt Tape and Tabs

The tape comes in continuous rolls in widths from ⅛ to 2 in., and in ⅛ and $\frac{3}{64}$ in. thicknesses. J. B. Dawn Products, 3905 W. 64 Pl., Chicago 29, Ill.

For more information—
Circle 15, inside back cover

Epoxy Coating Compound

A high viscosity opaque dip or brush coating compound providing adhesion to metals and plastics is available for manufacturers of electrical components and for application as a resilient coating. Identified by a light blue color, this compound has been prepared from a resilient epoxy resin and a special hardener. No solvents are present. Furane Plastics, Inc., Los Angeles, Calif.

For more information—
Circle 16, inside back cover

Low-shrinkage Silicone Rubbers

The compounds, with 60, 70, and 80 Shore A hardness, are said to be suitable from 80 F to 500 F. Reddish brown, these rubbers can be handled in standard molds used for regular synthetic rubber compounds. Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

For more information—
Circle 17, inside back cover

MECHANICAL COMPONENTS

Liquid Spring Built Into a Bolt

The spring is built within a bolt and has a low spring rate of 500 lb preload, 1000 lb end load, with 2½ in. stroke. Overall dimensions are 1¼ x 12¾ in. long with an external 1½-6 thread. Taylor Devices Inc., 188 Main St., N. Y.

For more information—
Circle 18, inside back cover

Metal Bellows Seals

These seals are designed to operate at temperatures in excess of 700 F, and lower than − 100 F. They are recommended for use where acids, solvents and other substances would destroy organic components of other types of seals.

Spring rate is said to be controlled to allow greater axial movement, with

CONTINUED ON PAGE 230

BRIDGEPORT BRASS
COPPER ALLOY BULLETIN

Bridgeport Brass Co. Reporting New Developments in Copper-Brass Alloys and Metalworking Methods

SPECIFY DURONZE WHEN YOU NEED A TOUGH, DURABLE ALLOY

by M. A. BUELL
Chief Staff Metallurgist

Duronze is one of the more versatile of the bronzes, combining the strong corrosion-resistant properties of copper with many of the mechanical properties of mild steel. It is available in several alloy compositions, the most popular of which are as follows:

	Duronze 606	Duronze 609	Duronze 707
Copper	96.00%	98.0%	91.0%
Silicon	2.85	2.0	2.0
Aluminum	–	–	7.0
Manganese	1.00	–	–

The Duronze family's high tensile strength and good machining make it a popular alloy for bolts, nuts, gears, valve stems and parts, and marine hardware.

Duronze 707 is best for machined and hot-forged parts. It does not, however, lend itself to cold-forming operations.

Duronze 606 and 609 offer, on the other hand, excellent cold-working properties in addition to excellent corrosion resistance.

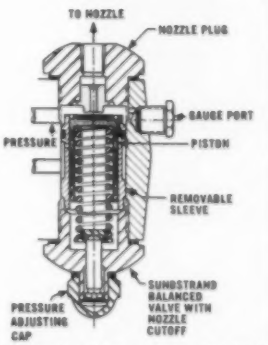
Full details on any Duronze alloy are available from your nearest Bridgeport Sales Office.

SOLVING YOUR PRODUCT AND PRODUCTION PROBLEMS

Of all the data, records and files kept by Bridgeport Technical Service, one of the largest is marked "Product and Production Problems —Solved." The experience brought to bear on a problem you may have with your product, or in the production of it, comes, in large measure, from cases similar to yours and frequently from cases exactly like yours.

Couple this successful experience with extensive facilities and you have a combination at your disposal that can be of great benefit to you. Bridgeport Technical Service works directly through your Bridgeport Salesman; when you outline for him your particular copper alloy problem you're calling on Bridgeport Technical Service.

Bridgeport Duronze 707 Helps Cut Cost of Vital Oil-Burner Pump Part



Schematic drawing showing position of nozzle plug insert in the burner valve assembly.

Bridgeport Duronze 707 nozzle port insert shown with nozzle plug.

The nozzle port insert for oil-burner pumps manufactured by Sundstrand Hydraulic Div., Sundstrand Machine Tool Co., Rockford, Ill., performs two vital functions: it provides positive fuel cutoff and prevents fuel leakage during stand-by periods.

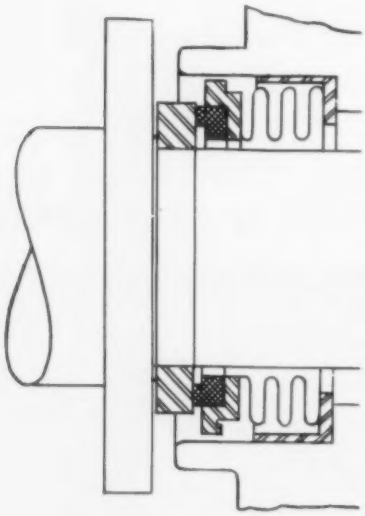
For these reasons, metals specifications and machining requirements are exacting. Resistance to continual corrosive effects of fuel is a must. Also, the material for the part has to be machined to close tolerances and must be capable of good surface finishes.

A Bridgeport salesman noticed that this insert was being machined from leaded phosphor bronze. He studied the materials specifications and production methods, then recommended a shift to Bridgeport Duronze 707 (Aluminum Silicon Bronze).

First, Duronze made possible substantial savings in materials cost. Second, Duronze's resistance to fuel-oil corrosion was equally as good as the previously used metal. Third, although the machinability of Duronze was slightly less than leaded phosphor bronze, the Bridgeport man's recommendations made the difference in machining time negligible.

The results speak for themselves. Sundstrand now uses Bridgeport Duronze 707 for the nozzle port insert on their *entire* line of oil-burner pumps.

BRIDGEPORT BRASS
Bridgeport Brass Company, Bridgeport 2, Connecticut, Offices in Principal Cities
In Canada: Noranda Copper and Brass Limited, Montreal



correct hydraulic balance furnished as required, and pressure resistance up to limit of bellows. Seals are supplied in brass, bronze, beryllium copper, Monel or stainless steel, with bellows joints of soft solder, silver solder, heliarc or resistance welded. Cartriseal Corp., 3515 W. Touhy Ave., Lincolnwood, Ill.

For more information—
Circle 19, inside back cover

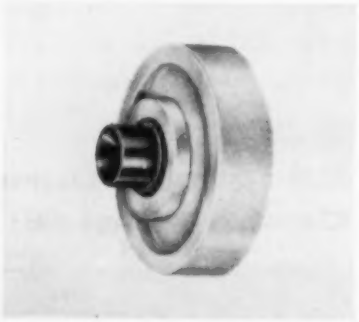
Multiple Feed Oilers

Operator can make finger-tip adjustments of this oils. Heads of friction screws are slotted to permit fine adjustments with small coin or screwdriver, if preferred. Available with manual or electric solenoid control, and with from 1 to 24 outlets, each with the new individual friction valve for feed control. Made in 10 oz, 1 pt., 1 qt., and 2½ qt capacities. Trico Fuse Mfg. Co., 2948 N. 5 St., Milwaukee 12, Wis.

For more information—
Circle 20, inside back cover

Stud and Nylon Roller

These bearings are a combination of a metal stud and a nylon roller, assembled before shipment. The stud is made of either zinc or cadmium-plated steel, stainless steel or aluminum. It is left soft for riveting and can also be supplied threaded, knurled



or grooved for special assemblies. General Bearing Co. Inc., 47 Roselle St., Mineola, N. Y.

For more information—
Circle 21, inside back cover

Miniature Electromagnetic Clutch

Available for electronic and instrument applications, the clutch has two input gear hubs and one output shaft. Normally both input hubs and the output shafts are free running. Energizing either coil clutches its respective input hub to the output shaft. The functions of the shafts may be reversed so that a single input can be connected to either of two outputs.

These units may be used as a speed or direction changer in servo applications. Units operate on d-c voltage and no slip rings are required. The four available standard sizes are: 0.594 x 1.978 in. long, excluding output shafts (3.5 in-oz min torque); 0.828 x 2.865 in., 14 in-oz min torque; 1.090 x 3.312 in., 26 in-oz min torque; 1.370 x 3.760 in., 52 in. oz min torque. Autotronics, Inc., Route 1, Box 812, Florissant, Mo.

For more information—
Circle 22, inside back cover

Flexible Coupling

These couplings are made with Type 303 stainless steel hubs, bored to ± 0.0002 in. tolerance, and come in three shaft sizes, ¼, ⅜ and ½ in diam. The couplings are said to control shaft-to-shaft misalignment and isolate torsional vibration. They permit insulation between units. Pic Design Corp., Div. Benrus Watch Co., Inc., 477 Atlantic Ave., Rockaway, N. Y.

For more information—
Circle 23, inside back cover

Automatic V-Belt Clutch

For electric motors and gasoline engines, this clutch pulls up to 3 hp at 3600 rpm. The clutch automatically adjusts for wide variations in belt tension and permits latitude in pulley centering.

Centrifugal segments are cammed toward the V-belt as they expand to effect greater gripping pressure against the V-belt, which serves as the friction material. The clutch employs a mechanical action to multiply the centrifugal force actuating the segments.

The load on the V-belt is used to further increase the clutch capacity and to lock the segments in expanded

CONTINUED ON PAGE 232

all the comforts of FOAM!

All the comforts of foam . . . and then some! Urethane foams, made from National Nacconates*, are full of profitable new ideas for designers and decorators, architects and engineers!

They'll cushion for comfort . . . but their resilience can be controlled to absorb shock as well. They insulate against heat, cold and sound, provide lightweight structural rigidity. They can be soft as down, yet have tensile strength, abrasion resistance and heat stability, and can be washed or dry-cleaned.

Urethane foams can be made in slabs or slices, foamed in place or pre-molded. They're tough enough to be cut and sewn, quilted, tacked or hog-ring-tied, heat-sealed or glued.

For additional information, contact National Aniline today.

URETHANE FOAMS
based on
NATIONAL NACCONATES

*Trademark name for National Aniline's Diisocyanates

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ALLIED CHEMICAL & DYE CORPORATION

Allied Chemical

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Akron Atlanta Boston Charlotte Chattanooga Chicago Columbus, Ga. Greensboro Los Angeles New Orleans Philadelphia Portland, Ore. Providence Richmond San Francisco Toronto

position. This provides disengaging speeds which are lower than engaging speeds, and the speed differential permits high speed take-off at maximum torque with full torque at reduced speeds. The clutch weighs 13 oz, has a pulley diameter of 2¾ in., and is available with ½, ⅝ or ¾ in. bore. Rev-O-Loc Clutch Corp., P. O. Box 1806, Milwaukee, Wis.

For more information—
Circle 24, inside back cover

Self-Aligning Anchor Nut

Accommodation of up to 8° angular misalignment in any direction between bolt holes and mounting surfaces is provided by an anchor nut. The nut is of all-metal construction made in conformance with all applicable requirements of military specifications, and is approved for use in temperatures up to 550 F. Available now in ¼ in. tap size. Kaynar Co., Box 2001, Terminal Annex, Los Angeles 54, Calif.

For more information—
Circle 25, inside back cover

Roller Chains

Five sizes of bushed chains and 15 sizes of bushed roller chain range from

2.609 to 9.00 in. pitch with ultimate strengths from 13,000 to 100,000 lb. All chains can be furnished in either straight or offset sidebar construction and with standard or special attachments. Majestic Stamping Co., 9310 Hubbell Ave., Detroit 28, Mich.

For more information—
Circle 26, inside back cover

Vinyl-Coated Cabinet Handle

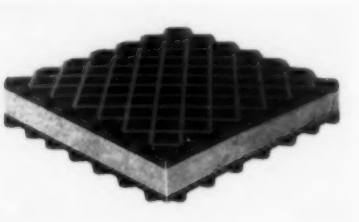
This vinyl-coated aluminum handle is designed for use on military and commercial electronic equipment cabinets. Dimensions are 5¼ x 2⅝ in. (with handle). Overall length 5¼ in., height, raised. United Technical Labs., Inc., Morristown, N. J.

For more information—
Circle 27, inside back cover

Traverse Drive

A variable speed transmission designed for traverse applications on winding machinery provides infinite speed range with accurate speed holding and speed reset. The drive maintains preset speed ratio between output and input shaft in spite of wide fluctuations of input speed, including jogging, fast acceleration and deceleration. Graham Transmissions Inc., Menomenee Falls, Wis.

For more information—
Circle 28, inside back cover



Neoprene-and-cork Machine Mounting

The pad consists of a layer of resilient cork permanently bonded between two layers of oil-resistant neoprene, which has been embossed in a waffle-type pattern. It is made in two types: standard capacity for loads to 60 psi, and high capacity for loads to 120 psi. Korfund Co., Inc., 48-19C 32 Pl., Long Island City 1, N. Y.

For more information—
Circle 29, inside back cover

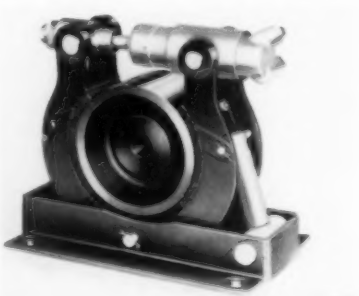
Non-ferrous Handles

Produced from non-ferrous materials, these handles are available with threaded, tapped or brazed anchoring bases to fit a variety of methods of attachment. Furnished in triple chrome plate. Alac, Inc., P. O. Box 471, Glendale, Calif.

For more information—
Circle 30, inside back cover

Hydraulic Brake

A 6 x 3 in. hydraulic brake is signed to provide braking and accurate control on light industrial cranes, mill roll stands and emergency stopping, holding and braking on other machines and devices. The standard brake is designed for use with hy-



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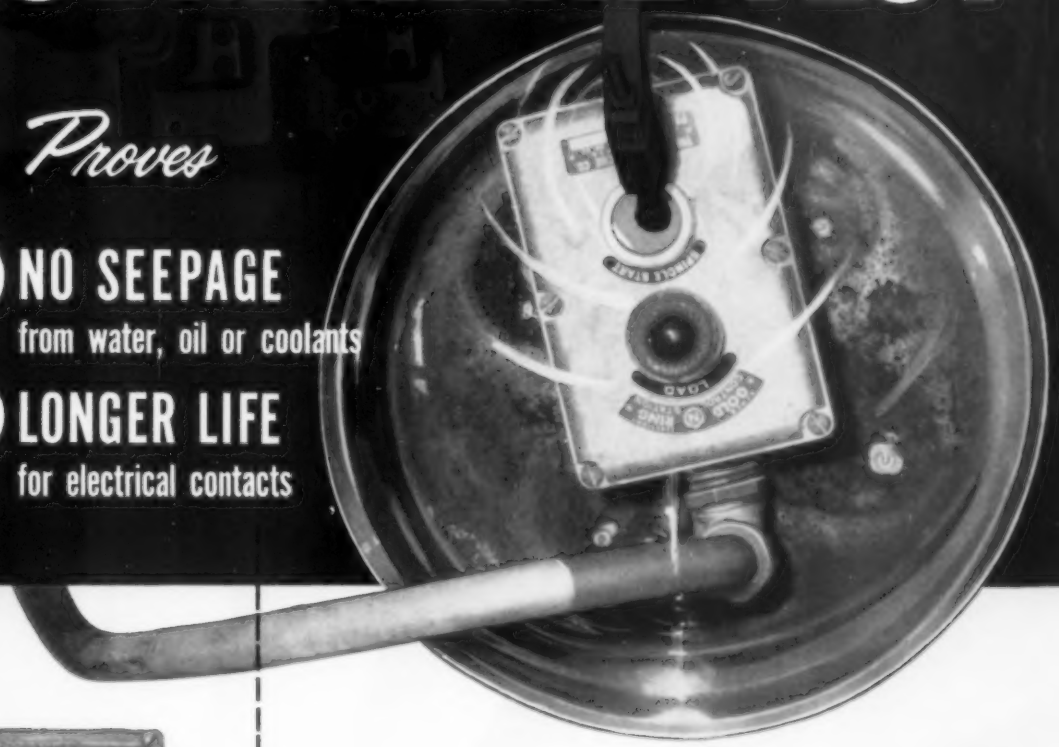
1,500,000 CYCLE

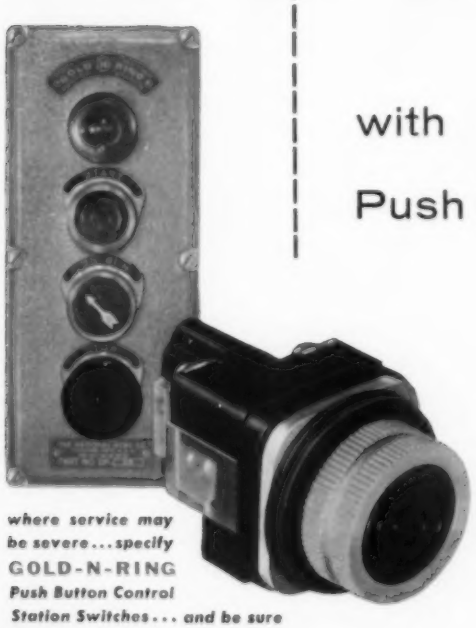
SUBMARINE TEST

Proves

1. **NO SEEPAGE** from water, oil or coolants
2. **LONGER LIFE** for electrical contacts



with THE NAMCO SEALTIGHT GOLD N RING Push Button Control Station Switch



where service may be severe... specify GOLD-N-RING *Push Button Control Station Switches... and be sure*

This test simulated conditions much more severe than even the most demanding electrical control service would ever duplicate. Without once "coming up for air," this standard GOLD-N-RING 2-unit control switch was immersed in fluid for more than 338 hours, during which momentary electrical contact was made 1,500,000 times—at the rate of 64 cycles per minute.

This test proved the flexing qualities of the synthetic, oil-resistant diaphragm beyond a doubt. It also pointed up the "staying qualities" of the extra-large, heavy-duty, alloy silver electrical contacts.

If you are looking for a switch that is designed and built to *keep on performing* long after your machine is installed, you'll find we talk your language.

Ask us to send Catalog ECS-56—or, better yet, ask a representative to call.

ELECTRICAL MANUFACTURING DIVISION . . .

National Acme

THE NATIONAL ACME COMPANY • 170 EAST 131ST STREET • CLEVELAND 8, OHIO

draulic brake fluid only.

The brake's hydraulic actuating cylinder is operated through a manual control cylinder equipped with a foot pedal. The brake arms are forced apart by a compression spring inside the actuating cylinder when the hydraulic pressure is released. The brake is equipped with an anti-drag device hinged between the base member and the right brake shoe arm to prevent the brake shoe from dragging on the brake wheel when the shoes are in released position. Wagner Electric Corp., 6400 Plymouth Ave., St. Louis 14, Mo.

For more information—
Circle 31, inside back cover

Position Lock for Caster-Mounted Equipment

A lock for castered trucks, scaffolds and other mobile equipment incorporates a kick release bar. Downward pressure on the pedal sets the shoe securely in contact with the floor and a downward pressure on the kick bar releases the lock. Bassick Co., Bridgeport 2, Conn.

For more information—
Circle 32, inside back cover

Through Threaded Inserts

Through-threaded aluminum inserts for molding into plastics, rubber and ceramics are available in plain, brass-plated and clear-anodized aluminum. These inserts have holes tapped with Class II threads to conform to ASME specifications in thread sizes from 4-40 to ¼-28. Yardley Precision Products Co., 33 Afton Ave., Yardley, Pa.

For more information—
Circle 33, inside back cover

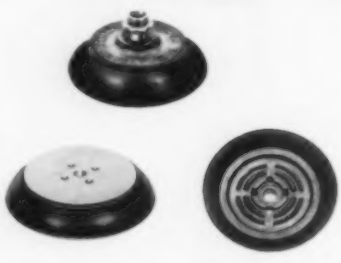
Nylon Base Glide

These glides have 1½ in. dia nylon bases. Tilting stem has 40° range of movement to accommodate splayed legs and to assure the base setting flat on floor. This series of glides is available with stems and/or sockets. Faultless Caster Corp., Evansville, Ind.

For more information—
Circle 34, inside back cover

Vacuum Cups

The cup is composed of pliable, molded neoprene vulcanized to an aluminum or cast iron plate. By attaching the cups to operating arms and installing vacuum lines, the cups can be used to pick up a wide variety of products. Ribbed section in the center of the cup assures maximum vacuum even on irregular surfaces, and prevents any tendency for the cup to collapse.



The vacuum cup has been used for turn-over applications, transfer of stampings and stacking of all types of products from containers to plate glass. The cups are stocked in two styles and four sizes, 3, 4, 5, and 6 ½ in. Stilson Tool Co., Roseville, Mich.

For more information—
Circle 35, inside back cover

Diaphragm Seals with Low Plastic Flow

The seal has been reported to have only 1% compression set after months of actual usage. It retains maximum flexibility characteristics over a temperature range of — 150 F to 400 F.

The material is available in a wide variety of designs and sizes. Bellofram Corp., Burlington, Mass.

For more information—
Circle 36, inside back cover

High-Temperature Lubricant

A solid film lubricant for operating temperatures up to 800 F provides a coefficient of friction which is said to been measured as low as 0.022 under high loads at 550 F. The latest silicones and phenolics are employed, together with micro-fine particles of moly-disulphide and synthetic graphite. Electrofilm, Inc., P. O. Box 106, N. Hollywood, Calif.

For more information—
Circle 37, inside back cover

Conveyor Bearings and Wheels

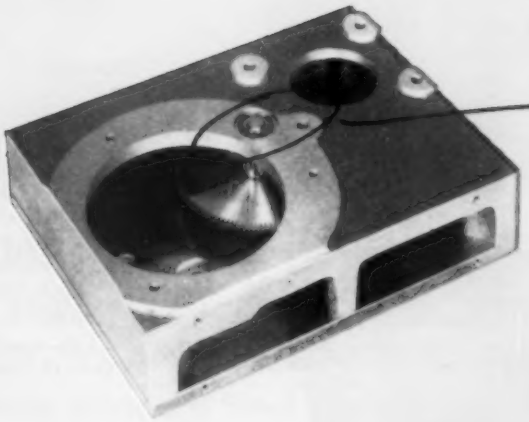
Wheels, with ¼ in. round cone hole size, are available in a range of sizes with single or double-row ball bearings, or with no ball bearings. They have outside shells or bright steel, zinc-plated steel or aluminum.

Bearings, either riveted or staked type, have a cone hole size to fit ⅜

—CONTINUED ON PAGE 236

Problem:

To assure instant response lasting precision in servo multiplier gear train



Solution:

FAFNIR
Precision Instrument
Bearings

In Electronic Associates' Analog Computer, instant response and unvarying operational precision of servo multiplier gear trains are a must. Fafnir Extra-Small Special-Precision Bearings are specified for this demanding application.

Precision-finished to exact tolerances, these high-quality bearings provide the sensitivity, running accuracy, and rigid support required. Both bearing types used are pre-lubricated at the factory. Equipped with shields for retention of grease and protection against contaminants, they keep maintenance at a minimum.

You, too, can count on Fafnir for effective and efficient solutions to precision bearing problems. You'll find a broad line of precision ball bearings to choose from — backed by the most modern production, assembly, and inspection facilities in the industry. Write for illustrated brochure containing detailed description of Fafnir's newly-expanded Instrument Bearing Division. The Fafnir Bearing Company, New Britain, Connecticut.

Fafnir Extra-Small Special-Precision Bearings are used in servo multiplier gear trains in Electronic Associates' Analog Computer. The Flanged Type (at left) features shoulders integral with the bearing to allow straight through boring for perfect alignment. The other is same size but unflanged.

FAFNIR
BALL BEARINGS
MOST COMPLETE LINE IN AMERICA

or $\frac{7}{16}$ in. hex shaft, and come in a range of sizes. Frantz Mfg. Co., Sterling, Ill.

For more information—
Circle 38, inside back cover

Die-cast Cap Nuts

These zinc alloy cap nuts can be ordered for immediate shipment from stock, in hex sizes from $\frac{7}{16}$ to $\frac{5}{8}$ in. Class 2 threads are tapped square with the face, and counterbored. Gries Reproducer Corp., 125 Beechwood Ave., New Rochelle, N. Y.

For more information—
Circle 39, inside back cover

Silicone Rubber O-rings

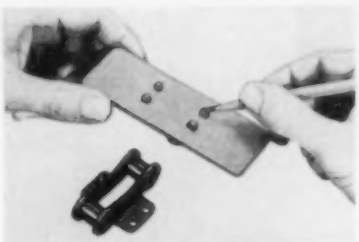
Red silicone rubber 0 rings are manufactured from 70 durometer hardness stock. They are available in standard AN sizes, are recommended for dry heat service on which synthetic rubber compounds and natural rubber do not maintain their rubber characteristics. The silicone rings resist oxidation, withstanding indefinitely continuous exposure to hot air and temperatures up to 300 F, and in most applications will withstand exposure to dry heat at temperatures from 300 to 500 F. Garlock Packing Co., 406 Main St., Palmyra, N. Y.

For more information—
Circle 40, inside back cover

Gears for Servomechanisms

Spur, spring and clutch gears, and bevel and miter gears are among the types available. In stock for immediate delivery are 48 and 64-pitch spur gears, in tooth multiples of eight and 10, with 14½° pressure angle, and minimum and maximum pitch diameters of $\frac{9}{16}$ and 4 in.; respectively. Stock gears have clamp hubs with $\frac{1}{4}$ in. bores. All gears are made to AGMA Precision Class 2 standard. Beckman-Helipot Corp., Newport Beach, Calif.

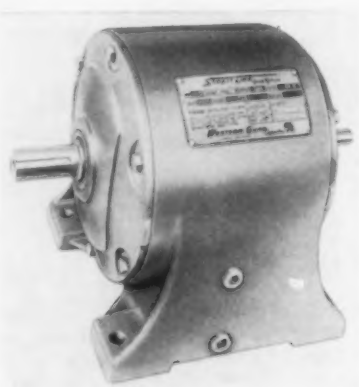
For more information—
Circle 41, inside back cover



Flat-top Conveyor Chain

A flat-top conveyor chain combines a rivet-free nylon carrying surface with steel roller chain. Link-Belt Co., Dept. PR, Prudential Plaza, Chicago 1, Ill.

For more information—
Circle 42, inside back cover



In-line Speed Reducer

These reducers are available in double and triple reduction. Double reduction units are offered in 15 standard ratios from 3.39:1 to 57.3:1, with ratings up to 100 hp. Triple reduction units are available in nine ratios from 82.1:1 to 190.7:1, with ratings up to 50 hp.

Complete interchangeability of individual parts, from frame sizes through packaged sub-assemblies, is provided. Western Gear Corp., P. O. Box 182, Lynwood, Calif.

For more information—
Circle 43, inside back cover

Rod-end Bearings

Two-piece (ball and body only, self-aligning, plain, spherical, rod end bearings are available for $\frac{1}{4}$ to $\frac{3}{4}$ in. bore and larger, with radial ultimate load capacities of 7000 to 33,300 lb and higher. Same bore sizes available for high-temperature operations to 1000 F. Southwest Products Co., 1705 S. Mountain Ave., Monrovia, Calif.

For more information—
Circle 44, inside back cover

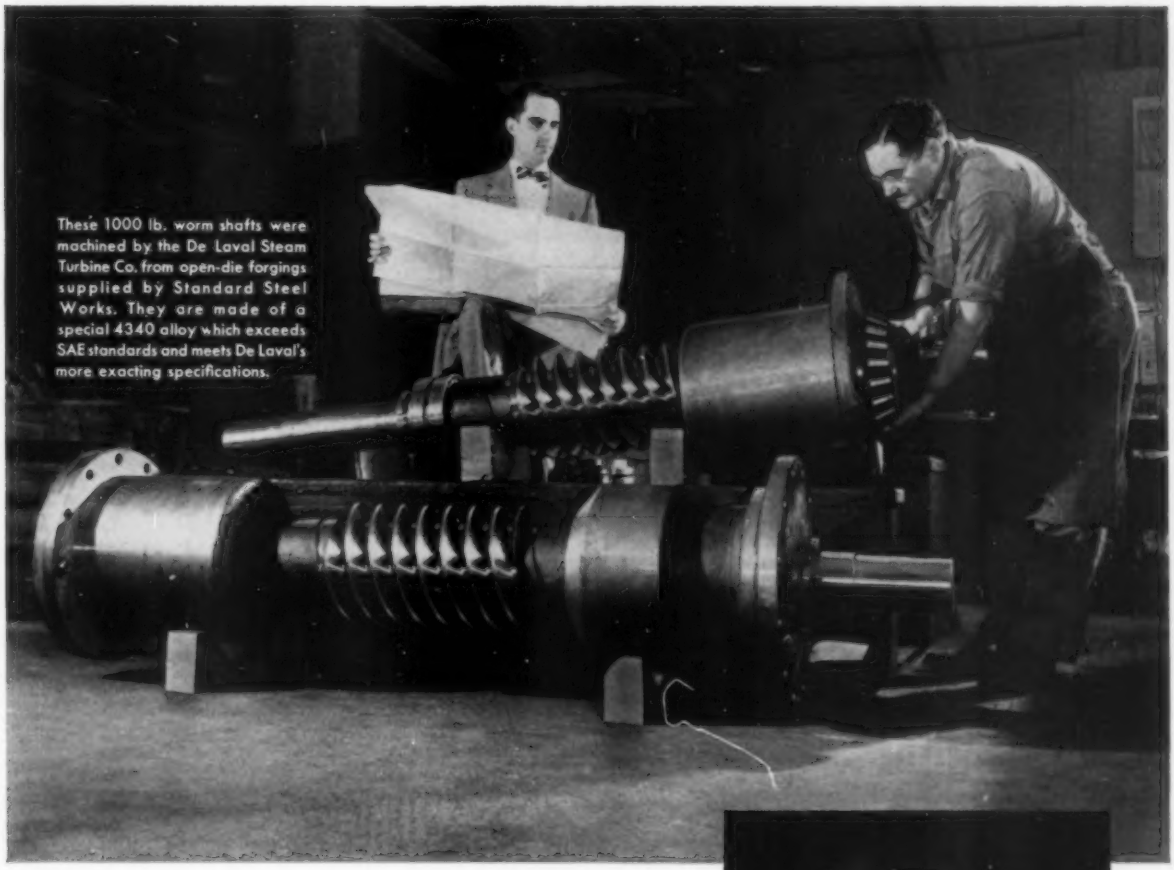
ELECTRICAL POWER, CONTROL

Magnetic Memory Drum

Over 12,000 bits of data and associated clock and reference information can be stored in this miniature memory drum. The device may be used in data-handling systems or as a laboratory testing instrument.

The standard laboratory drum measures 3½ in. dia and contains twelve information channels plus clock and fiducial channels. Each channel is 0.070 in. in width with a capacity of 1024 bits. Clock and fiducial channels are an integral part of the aluminum drum.

CONTINUED ON PAGE 238



These 1000 lb. worm shafts were machined by the De Laval Steam Turbine Co. from open-die forgings supplied by Standard Steel Works. They are made of a special 4340 alloy which exceeds SAE standards and meets De Laval's more exacting specifications.

"It used to take us 12 weeks to get the required forgings for these worm shafts. We now get them in 6 weeks —from Standard Steel Works"

We accommodate De Laval's Mr. Schwarz in two ways so as to give him the service he wants: (1) We keep ingots and billets of the special high quality steel De Laval demands on order point—we can meet even the largest requirements on short notice; (2) each forging is tested and inspected—the product of complete and precise quality control. Mr. Schwarz knows he can expect not only service, but also quality when he orders forgings and castings from us.

Mr. Schwarz is just one of many industrial executives who have been impressed with the extra *service* we enjoy rendering. Not a month goes by that De Laval doesn't come to us with some special request which we can meet, and cheerfully. And hardly a day goes by that one of our many customers doesn't put our boast of personalized service to the test. Why don't you let us handle your next forging or casting requirement. You'll appreciate our service as well as our know-how. Write Dept. 4F.

"It's not unusual for me to be invited out on the floor to talk with the men who are actually making castings and forgings for us. In my opinion it's the personal interest which the men at Standard take in a customer's order that lies behind the consistently excellent service they render," *says E. T. Schwarz, Director of Purchasing, De Laval Steam Turbine Co., Trenton, N.J.*

Standard Steel Works Division

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Axially-free, spring-loaded connectors permit instant adjustment or replacement, minimizes machine "down-time." Apex double universal joint illustrated is used on regulator wheel drive on centerless grinder. Covers completely seal all moving parts, provide sustained lubrication, protect assembly against abrasives and the coolant in which it must operate.

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Specially compounded flexible covers, filled with lubricant and sealed, provide a service-proved means of providing trouble-free operation for periods often exceeding the normal service life of the equipment on which Apex joints are installed. The flexible cover and sealed-in lubricant serve as a vibration dampener and help inhibit corrosion. On applications where universal joints must operate in water, gases, corrosive liquids, dust or abrasive-laden atmospheres, or in extremes of temperatures, only Apex covered universal joints will meet operating requirements, provide superior performance.

Does your design problem involve maximum joint strength? Apex combines high-alloy electric furnace aircraft quality steels and unique structural design to insure greatest joint strength.

Are safety and minimum backlash major design factors? All elements in Apex universal joints are carefully heat-treated, precision-machined, ground and fitted to extremely close tolerances.

Do you need favorable strength-weight ratio? A very low deflection rate? Axial and torsional strength? Superior fatigue resistance? Overload capacity? You can have all these in Apex universal joints and assemblies.

Or do you need engineering assistance on your drive-line design problem? We'll gladly work along with you to help develop a practical solution to your universal joint application problem. Our new Catalog 28 is ready . . . send name and address (on your company letterhead please) for your copy.

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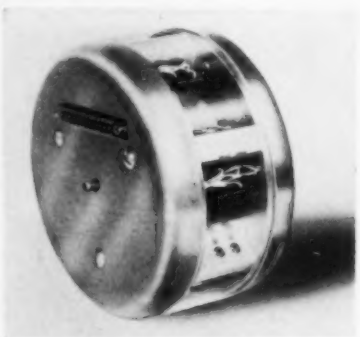
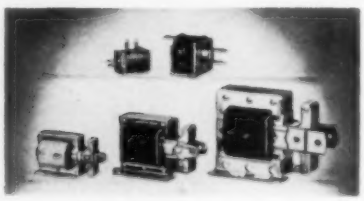


The drum is belt-driven with variable speeds to 15,000 rpm. Access time is approximately 1.25 millisec. B J Electronics, Borg-Warner Corp., 3300 Newport Blvd., Santa Ana, Calif.

For more information—
Circle 45, inside back cover



Custom-Designed Solenoids From Stock

A total of 17 models provide 34 differing specifications. Pull and/or push capacities range up to 45 lb, sizes from $1\frac{3}{8}$ x $1\frac{3}{8}$ in. to 3 x 3 in., stroke lengths fractional to 2 in.

Double shading coils are said to provide high sealed pull without hammer or excessive a-c hum. Dormeyer Industries, Dept. PEN, 3418 N. Milwaukee Ave., Chicago 41, Ill.

For more information—
Circle 46, inside back cover

Miniature Level-sensing Switches

Electrolytic level switches, originally designed for missile directional systems, are arc-shaped gravity sensor devices. Unlike mercury-filled levelers, these units are made for both off-on and proportional control in both vertical and lateral directions. When filled with an electrolyte, the switches indicate level and deviation from level within tenths of degrees.

(Continued on page 242)

new pressure switch

...has the appearance and performance you need

Looking for something new, something better, to control or limit the pressure of air, gas, oil? Use this new Honeywell Industrial Pressure Switch . . . designed to complement the most attractive equipment or panels . . . constructed to give lasting performance in the most rugged applications. Use it to make your equipment more automatic, improve your system, provide trouble-free service.

Here are the facts you'll want to know:

- Designed for flush or surface mounting
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- Visible mercury switch position (SPST or SPDT)
- Front-of-case set-point and differential adjustment
- Selection of pressure ranges to 3000 psi
- Specifically designed and constructed for industrial use . . . ½" pipe connection
- Available in explosion-proof construction

For complete data, a consultation on applications, prices for any quantity . . . get in touch with your local Honeywell sales engineer. He's as near as your phone. MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

● **REFERENCE DATA: Write for Specification sheet S1011-3 "New Honeywell Industrial Pressuretrol"**

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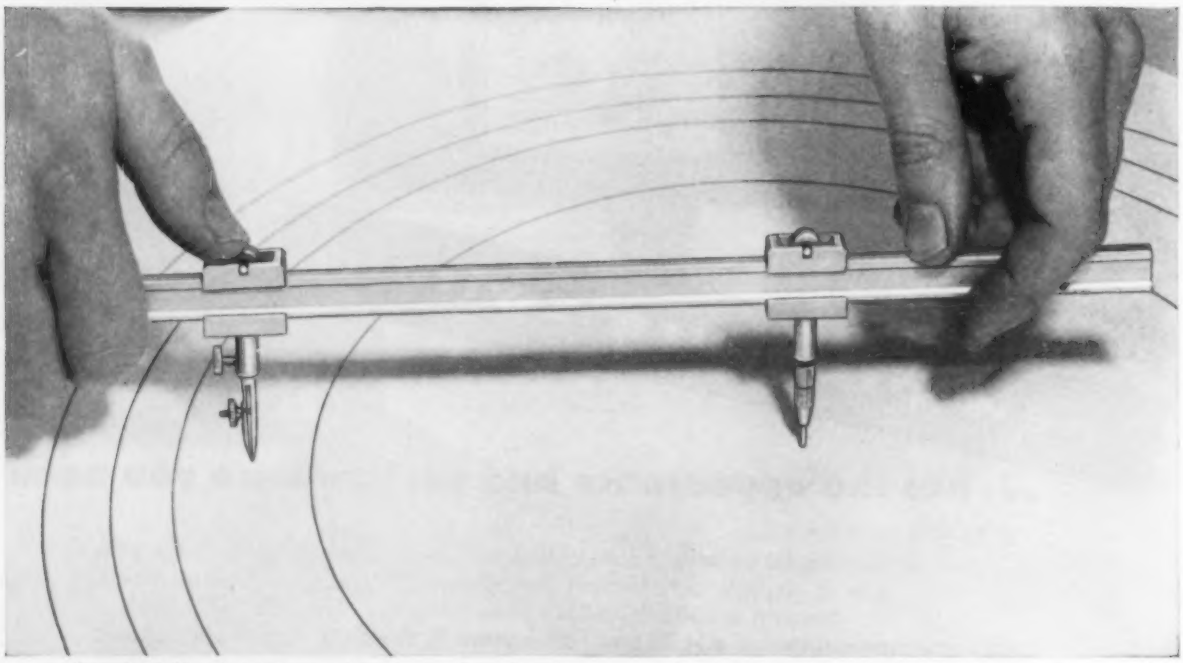
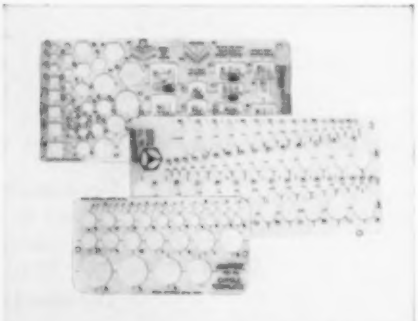


Thumb Adjusting Beam Compass. One hand does it all! Your thumb moves a knurled thumb roller, located on top of the assembly slide, to the radius desired. Same hand then moves compass to draw circle or arc. It's fast, easy, and accurate. Constructed of anodized aluminum. One of the lightest, sturdiest and least expensive beam compasses on the market. Comes with pencil, pen, and needle parts and 13″ beam (25″, 38″, and 50″ beams also available).

Paramount Giant Bow Compass. Draw truer circles — 1/8″ to 11″ diameter — faster and easier! Improved center thumbscrew and headpiece bearings eliminate any free play at any setting. Durable nickel silver construction.

Stainless-Supreme Drawing Instruments. Get the higher precision, lifetime durability, and beauty offered only by instruments made entirely of stainless steel. Will not tarnish or suffer damage by perspiration. Five times harder than instruments made of brass or German silver. Specially hardened, swivel-type ruling pen blades are easy to clean, will remain sharp. Swiss Precision-made.



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Cross section lines will not reproduce. Prints show only what you draw.

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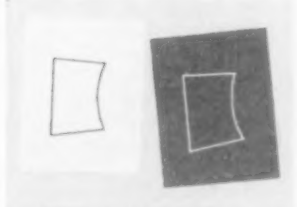

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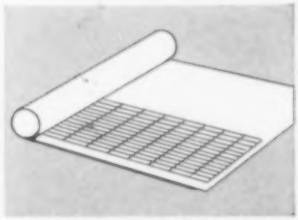

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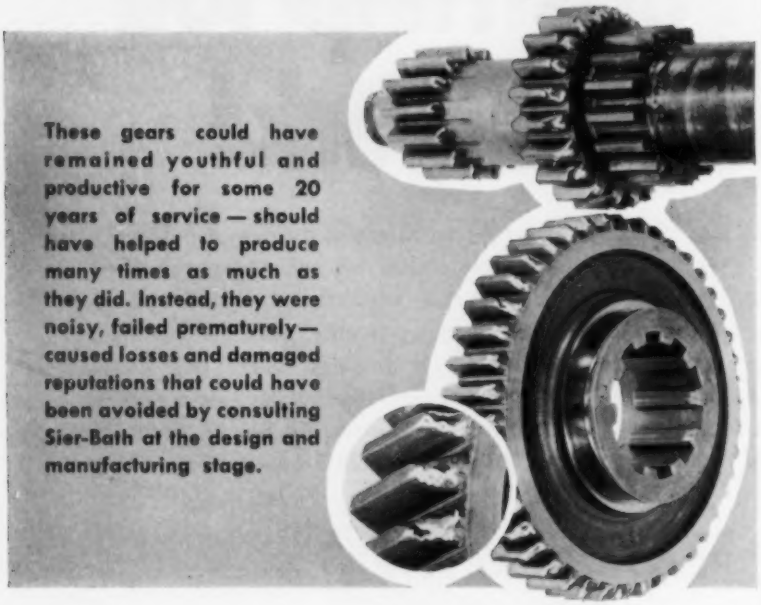
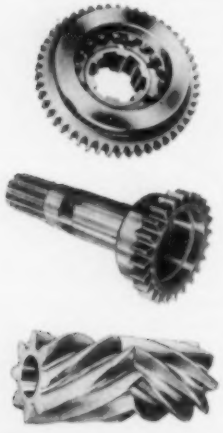
The Potential Gold Mine in these Gears never paid off!



These gears could have remained youthful and productive for some 20 years of service — should have helped to produce many times as much as they did. Instead, they were noisy, failed prematurely—caused losses and damaged reputations that could have been avoided by consulting Sier-Bath at the design and manufacturing stage.

There is only one best gear design for each application. Have Sier-Bath manufacture it into your gears to eliminate gear troubles and failures, and most important, gain economies and add operating advantages that keep your machines ahead of competition and geared to the increased requirements of tomorrow.



Our chief gear engineer was for many years a gear consultant serving most of the nation's leading gear manufacturers. Solving gear problems and gear failures is the forte of the staff he has developed since becoming our chief gear engineer. This staff is at your service to help you obtain gears of the best design — analyze your drawings — study your application — provide free engineering consultation to achieve maximum loads, speeds, precision and life expectancy, with a minimum of size and cost of your gears.

Send us your gear prints or problems for study and quotation. Or, have a Sier-Bath gear specialist call to discuss your gear requirements.

Sier-Bath PRECISION GEARS

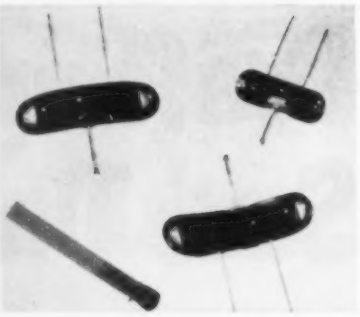
All kinds of gears—all materials
Made—cut—shaved—ground teeth
42" maximum diameter
12 or more of a kind, depending on size.

Sier-Bath GEAR & PUMP CO., Inc.

9238 HUDSON BOULEVARD NORTH BERGEN, N. J.

Founded 1905 Members A.G.M.A.

Also manufacturers of Rotary Pumps and Flexible Gear Couplings



The switches are said to have six times less mass shift than mercury counterparts. They maintain optimum electrode-electrolyte contact throughout all flight maneuvers, even in tight high-speed turns.

Made to conform to military temperature specifications, the switches can withstand temperatures up to 200 C. They have also operated at — 60 C and lower. Two sizes are available, ½ and 1 in.

One hollow and two solid platinum leads are sealed with precise spacing into the sensor's surface. Electrolyte is inserted through the hollow lead, which is then arc-welded closed. Calibration is accomplished during the filling operation. Corning Glass Works, Corning, N. Y.

For more information—
Circle 47, inside back cover

High-temperature Wire and Cable

Hook-up wires, miniature coaxial and coaxial cables and multiconductor cables are available, insulated with extruded as well as spirally wound and fused Teflon. A range of 14 colors and/or spiral striping are produced, on solid, standard and special strandings of silver plated copper wire conductors of from AWG 32 through AWG 10.

The hook-up wire has a rating of 90 C. to 250 C. Times Wire & Cable Co., Wallingford, Conn.

For more information—
Circle 48, inside back cover

Engine Safety Switch

A temperature-and-pressure-sensitive switch designed to warn off overheating diesel engines before internal damage results responds to abnormal temperatures (up to 250 F) or pres-

(Continued on page 244)

J&L cold drawn ELECTRICWELD tubing with a superior SPECIAL SMOOTH I.D. finish

Cold drawn ELECTRICWELD tubing with the superior smooth I.D. finish will cut your production costs in applications like these:

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This new drawn-over-mandrel grade tubing with its mirror-like surface finish helps reduce or eliminate costly machining on many applications. For example, it may be used, without inside honing, for many cylinders through which plungers are passed.

ELECTRICWELD tubing withstands high internal hydrostatic pressures; carries heavy torsion loads; resists high-frequency vibration. It offers a favorable weight-to-strength ratio where loading occurs in all directions.

It is furnished in OD sizes from ½ inch to 2⅞ inches and in wall thickness from 20 to 10 gauge, 0.035 and 0.134 inch. Send coupon today for complete information.

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These standard switches can be modified to fit your application:

- **TYPE A** — up to 8 positions, 7 sections maximum, detent-mechanism, rating 5 amperes — 125 volts a-c/30 volts d-c.
- **TYPE AF** — up to 8 positions, 6 sections maximum, detent-action, rating with resistive load 5 amperes at 28 volts d-c or 115 volts 400 cps, per MIL-S-6807.
- **TYPE P** — Multi-section, up to 4 positions, snap-action, rating 10 amperes — 125 volts a-c, 5 amperes — 125 volts d-c, 30, 60, 100, 200 amperes at 500 volts a-c, or 250 volts d-c. Can be assembled to meet Specification MIL-S-15291.
- **TYPE JR** — up to 8 positions, 30 sections maximum, detent-action, rating 10 amperes at 125 volts a-c, 5 amperes 125 volts d-c.
- **TYPE JD-JS** — up to 8 positions, 5 sections maximum, detent-action or snap-action, rating 30 amperes at 230 volts a-c.
- **TYPE HT** — up to 16 positions, 6 sections maximum, detent-action, rating 5 amperes at 125 volts a-c.
- Bureau of Ships No. 9000-S6202-74085 rating 10 amperes at 120 volts a-c. BuShips 9000-S6202-74090, 9000-S6202-74096, and 9000-S6202-74224, ratings 30, 60, and 200 amperes, 500 volts a-c — 250 volts d-c.

Write for data sheets or catalog on ESCO rotary multipole switches — or send us your requirements and we'll give you full specifications on the ESCO switch that meets YOUR need.

ESCO of WEYMOUTH
ELECTRO SWITCH CORPORATION
Weymouth 88, Massachusetts

sures (to 70 psi) to stop or idle the engine, or set off an alarm. The switch actually comprises two separate systems, one for temperature measurement, one for pressure measurement. Both are mounted on a common frame and enclosed in a metal case.

The temperature system is a remote bulb, capillary and diaphragm assembly that measures engine coolant temperature. The pressure system measures engine lubricating oil. As the temperature rises or the pressure drops to danger levels, small switches on each system trip the final engine control element or the alarm circuit. Built into the temperature system is a "fail-safe" arrangement that will idle or stop the engine if damage occurs to any of the components of the measuring system. Another arrangement allows temperature and pressure set points to be adjusted in the field. Minneapolis - Honeywell Regulator Co., Wayne & Windrim Ave., Phila., Pa.

For more information—
Circle 49, inside back cover

D-c Power Supply

A tubeless magnetic amplifier-controlled d-c power supply with a voltage range of 0 to 150 v, at currents from 0 to 1½ amp, is regulated to ± 1% for line or load. A compensating adjustment control secures positive or negative impedance, giving 0% load

(Continued on page 248)

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When ordering, specify ¼", ⅜" or ⅜" tubes. Style TF.

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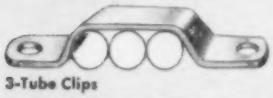
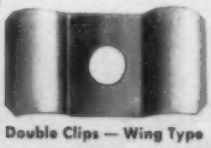
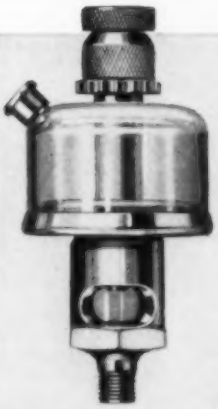


3-Tube Clips

4-Tube Clips



Double Clips — Wing Type

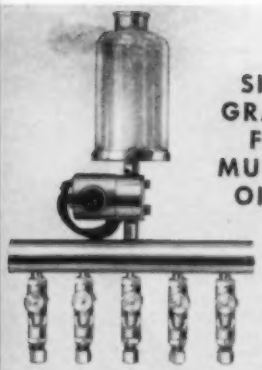


SIGHT GRAVITY FEED OILERS

Rate of oil flow regulated by needle valve, directly observed through sight glass in stem. Shut-off knob does not affect needle valve adjustment. Visible oil supply. Non-breakable. Tops in convenience and dependability, at low cost. Style NFU—No. 3602-A.

GEAR CASE GAUGES

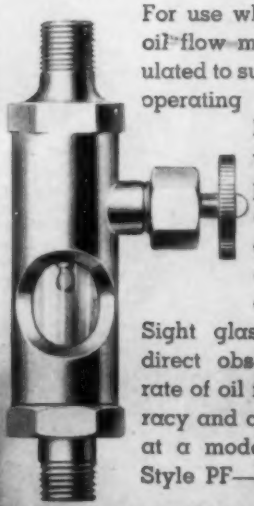
This oil gauge plug permits instant checking of oil level within a transmission or gear case. For use where construction permits insertion in tapped hole. A valuable addition to any such equipment — at very low cost. Style BW—No. 4042.



SIGHT GRAVITY FEED MULTIPLE OILERS

This one unit replaces 3 to 8 individual oilers. Maximum practicality in a small central lubrication system. Positive cut-off during idle periods. Individual vibration-proof needle valve adjustments. With solenoid control (Illustrated): Style MDS—No. 4685-A. Without solenoid: Style MD.

SIGHT GAUGES



For use where rate of oil flow must be regulated to suit changing operating conditions. Needle valve permits extremely accurate adjustment of oil feed. Sight glass provides direct observation of rate of oil flow. Accuracy and convenience at a moderate price. Style PF—No. 4290.

Don't price yourself out of the market. When you design proper lubrication into your equipment, specify GITS Lubricating Devices—the widest selection available anywhere. The items pictured above are only a few of our many thousands of lubricating devices. At the design stage, get the GITS story. Free Engineering Service. Send NOW for your free Catalog.

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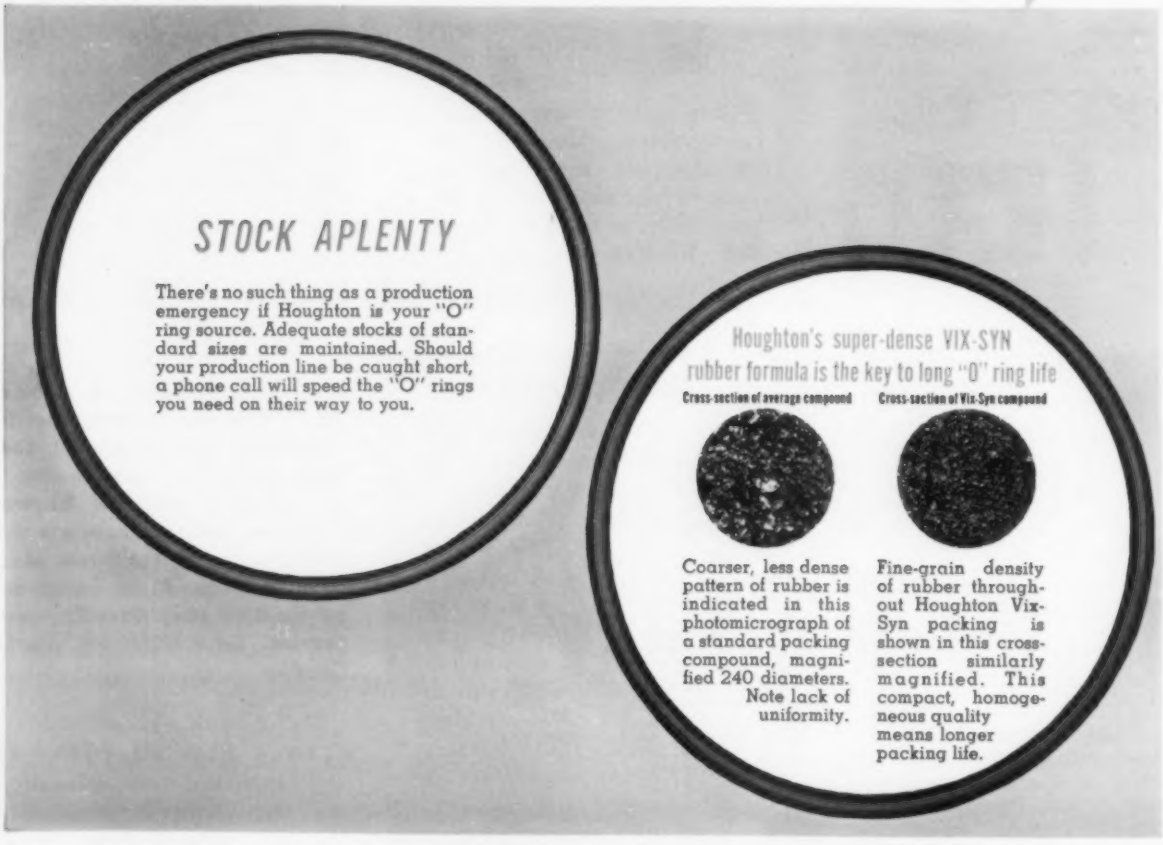
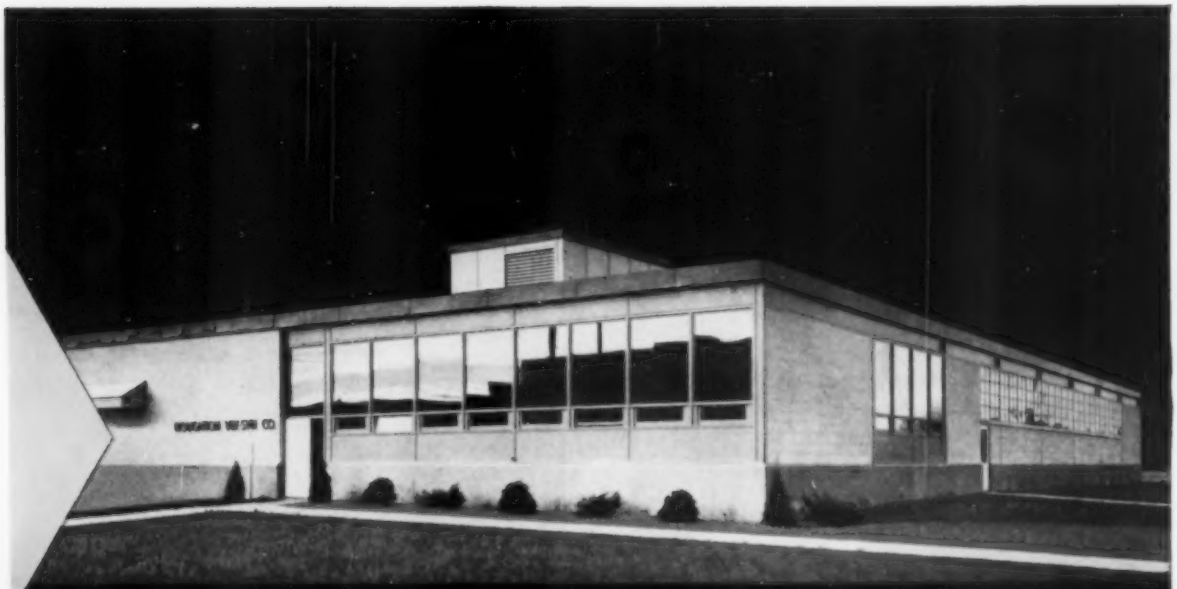
This ultra-modern plant supplies—in volume—"O" rings with outstanding performance advantages. VIX-SYN rings are supplied in standard compounds covering a wide range of needs. If your problem requires a special compound because of heat, pressure or fluid conditions, we will work with you either to select one already available or to develop the type needed.


STOCK APLENTY
There's no such thing as a production emergency if Houghton is your "O" ring source. Adequate stocks of standard sizes are maintained. Should your production line be caught short, a phone call will speed the "O" rings you need on their way to you.
Houghton's super-dense VIX-SYN rubber formula is the key to long "O" ring life
Cross-section of average compound
Cross-section of Vix-Syn compound
Coarser, less dense pattern of rubber is indicated in this photomicrograph of a standard packing compound, magnified 240 diameters. Note lack of uniformity.
Fine-grain density of rubber throughout Houghton Vix-Syn packing is shown in this cross-section similarly magnified. This compact, homogeneous quality means longer packing life.



Houghton Vix-Syn plant

More Capacity
On The Way
Because more companies are choosing Houghton "O" rings every day, added plant capacity is on the way. It has to be, because Houghton will not compromise the present prompt service or decrease stock volume. New or old, every customer gets the same personalized service.

Houghton VIX-SYN Synthetic Rubber is also available in "V's", "U"-cups and special shapes and in a variety of compounds and durometer readings. Vim leather back-up washers specifically designed for use with "O" rings, and fabricated rubber packings, are also supplied. Ask your Houghton Man for latest bulletin, or write to E. F. Houghton & Co., 303 W. Lehigh Ave., Phila. 33, Pa.

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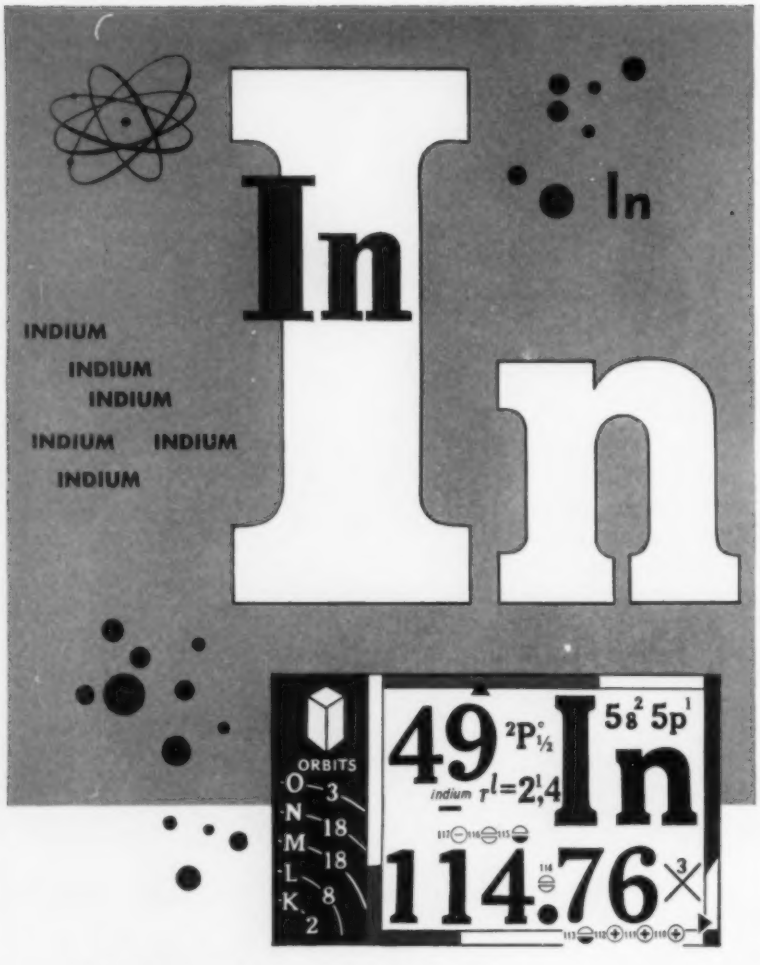

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regulation. Ripple is 0.1% for all line or load conditions. Transient response is better than 0.2 sec. Line input range is from 105 to 125 v a-c, 60 cps.

Dimensions are 8¾ x 19 x 14⅞ in. deep. Universal Electronics Co., 1720-22 St., Santa Monica, Calif.

For more information—
Circle 50, inside back cover

Meter-Relay

This unit measures 1 x 1¼ x 2¼ in. overall. It fits a nine-pin miniature socket. The case is solder-sealed.

A moving coil armature rotates in the flux gap of an Alnico magnet. The moving element is similar to voltmeters and microammeters. A locking coil in the moving element develops additional torque to drive the contacts together with considerable pressure.

Range is 50 ua to 10 amp and 10 mv to 500 v at 2%. Ranges down to 0.2 microamp (12,000 ohm) and 0.1 milliv (5 ohm) at reduced accuracy. The meter-relay is supplied for either a-c or d-c. All ranges may be compensated for ambient temperatures of — 40 F to 150 F. Assembly Products, Inc., P. O. Box XX, Palm Springs, Calif.

For more information—
Circle 51, inside back cover

Time Delay Relays

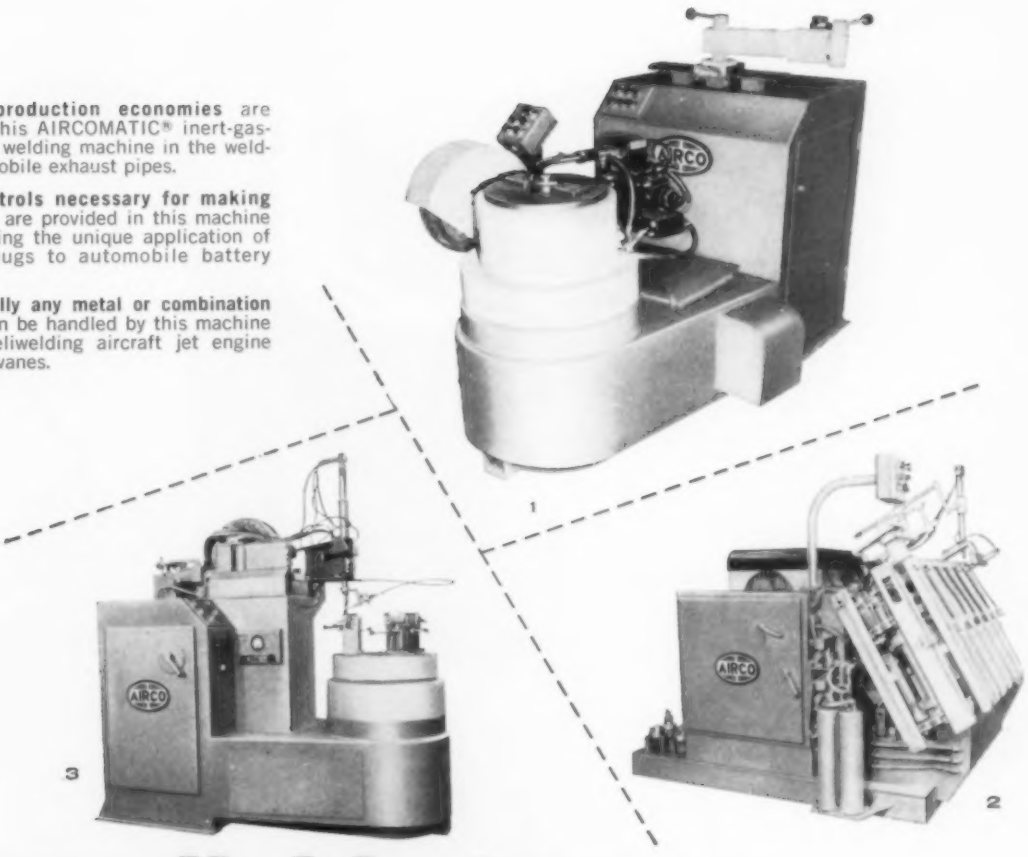
Four basic types of circuitry are used in these timers. Type 1 uses subminiature relays with slugged coils. Type 2 is used for short delay times and broad tolerance applications, and contains resistance capacitor networks. Type 3 uses germanium transistors

(Continued on page 252)

1 **Many production economies** are offered by this AIRCOMATIC® inert-gas-shielded arc welding machine in the welding of automobile exhaust pipes.

2 **All controls necessary for making sound welds** are provided in this machine for Heliwelding the unique application of aluminum lugs to automobile battery cables.

3 **Practically any metal or combination of metals** can be handled by this machine used for Heliwelding aircraft jet engine turbine exit vanes.



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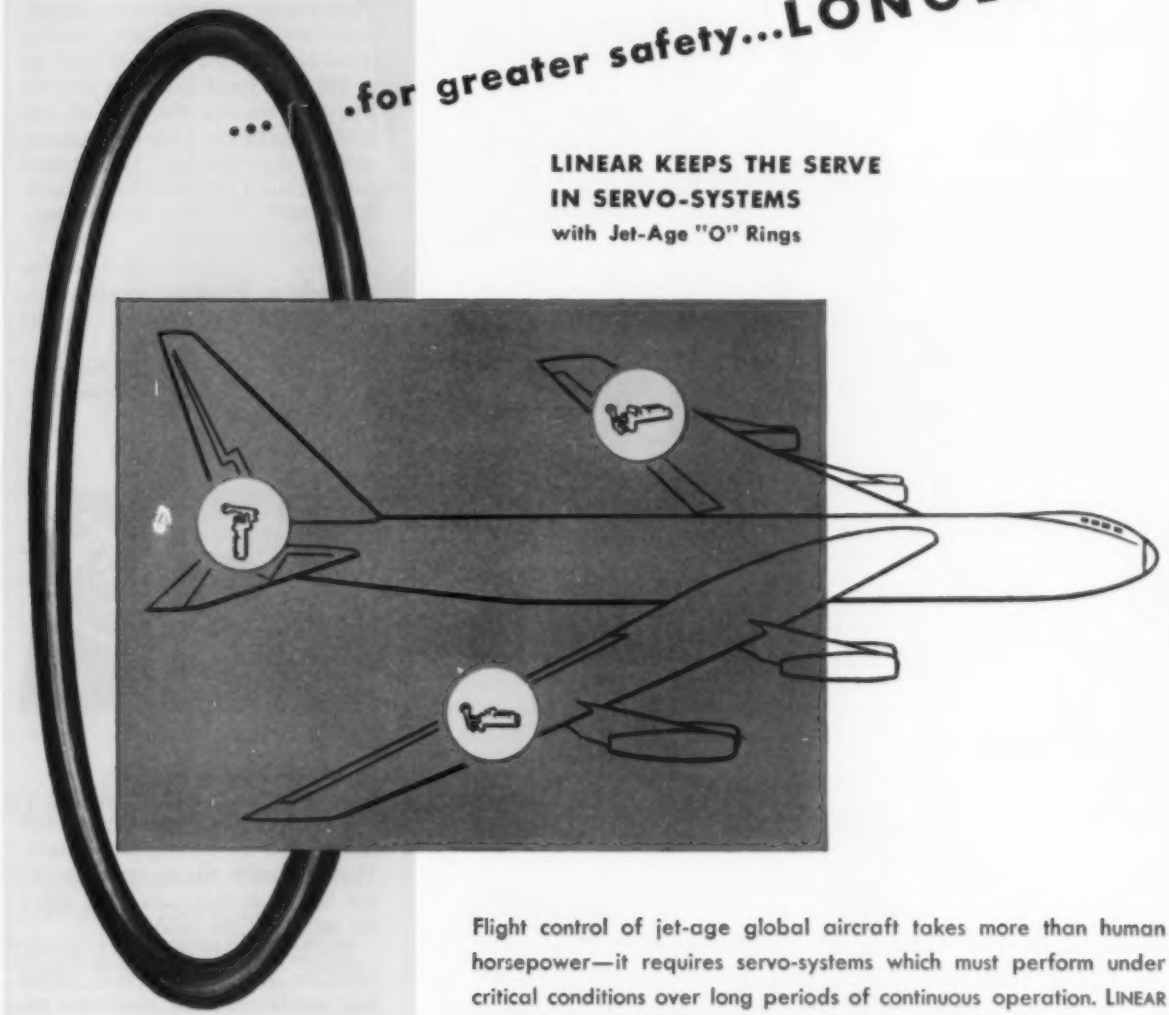

Flight control of jet-age global aircraft takes more than human horsepower—it requires servo-systems which must perform under critical conditions over long periods of continuous operation. LINEAR has developed "O" rings and seals that keep the serve in servo-systems—to keep these planes in the air longer—safely.

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and be sure to specify LINEAR "O" Rings.

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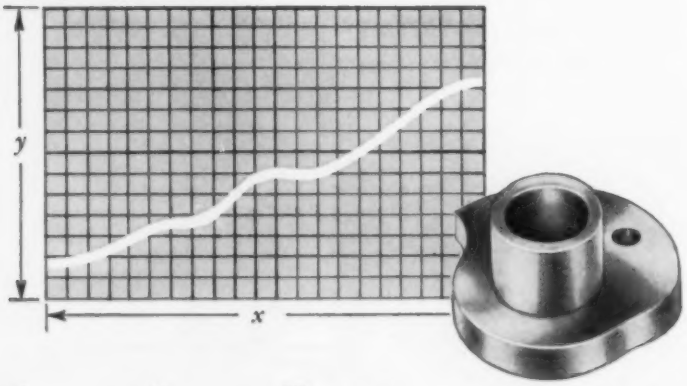
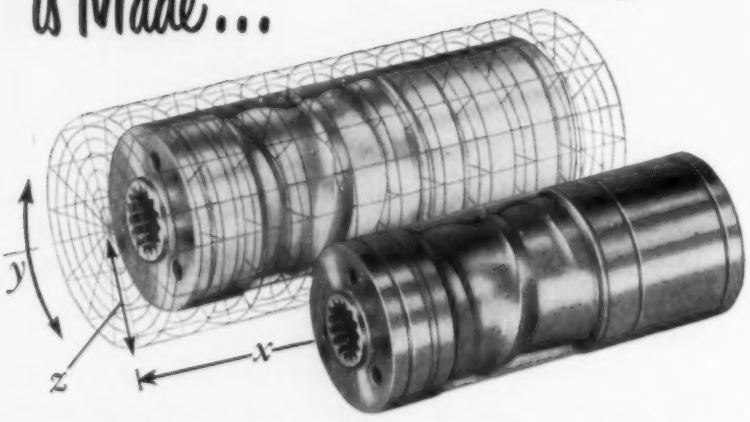
Here's How a 2 Dimensional Cam is Made...



Here's How a 3 Dimensional Cam is Made...

$z = f(x,y)$



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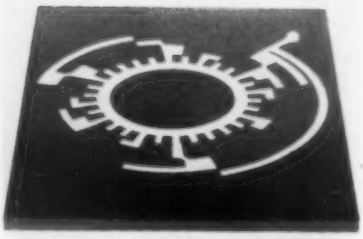
where maximum temperature requirements are 165 F and silicon junction transistors are used for units rated up to 250 F. Type 4 is used in long delays and requires the use of subminiature vacuum tubes for accuracy, stability and reliability. These timers can be divided into three basic classifications: delayed pull-in, delayed drop-out and pulse output.

Pulse rates from 40 cps to 1 per min are available. Electronic Specialty Co., 5121 San Fernando Road, Los Angeles 39, Calif.

For more information—
Circle 52, inside back cover



Flush Etched Circuits

The circuits are printed, etched and flushed into an epoxy-glass laminate. They are said to remain stable and do not have a tendency to creep above the surface of the laminate.

The circuits are resistant to shock, vibration and abrasion and possess heat resistance under conditions encountered in dip, roll and hand soldering. Mica Corp., 4031 Elenda St., Culver City, Calif.

For more information—
Circle 53, inside back cover

Plug-in Counting Circuits

Subminiature, transistorized counting circuits are made in two basic types: plug-in and with a cartridge configuration.

The plug-in package fits standard seven-pin miniature socket and can be retained with a standard tube shield. The cartridge is a rectangular flat shape. The binary counter unit has dual output and dual reset terminals. It is for use as a binary or as a flipflop. It can be used up to the 175 kc range.

The trigger type will convert a sine wave or other wave shape into a fast

(Continued on page 393)

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MOST BEAUTIFUL MOTORS IN ALL THE WORLD...

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They are available in T.E.N.V. and T.E.F.C. types. Small, compact and featuring the very latest in lightweight materials.

For good looks and precision operating characteristics, there is nothing on the market to equal these jewel-like units.

Precision balance

Reuland motors are built to precise specifications like a fine tool. Each unit is dynamically balanced at the factory to assure vibrationless operation.

Heavy-duty ball bearings, located at each side of the rotor, assist in maintaining this characteristic which is so vital to precise work. Exact tolerances are likewise maintained throughout final assembly.

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The radial air gap design of these motors permits the use of a lighter weight, low inertia rotor. This light weight, low inertia feature assures smooth starts and quick stops.

This rotor is also of a special narrow design which has shortened up the overall length of the motor to give a thinner, "wafer" effect.

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The smoothly finished surfaces of Reuland machine tool motors are a match for the most expensive tool. All castings are specially processed for smoothness and are given a baked enamel finish.

This fine-quality finish, together with the motors' naturally pleasing lines, assure a harmonious blend with the lines of every machine tool on which they are mounted. (When desired, the motor's frame size can even be varied to fit an *exact* contour of the machine.)

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6. All-aluminum motor frames
7. "Xpandable" motor design

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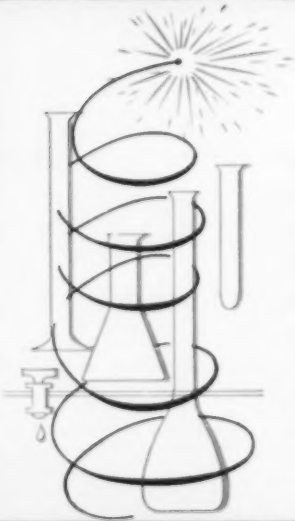
Gilbert Gleichner, "pushbutton electro-chemist" and operator of our newest Stevens automatic anodizing unit. Bert says he's getting more done, better, in less time, than he ever has before.



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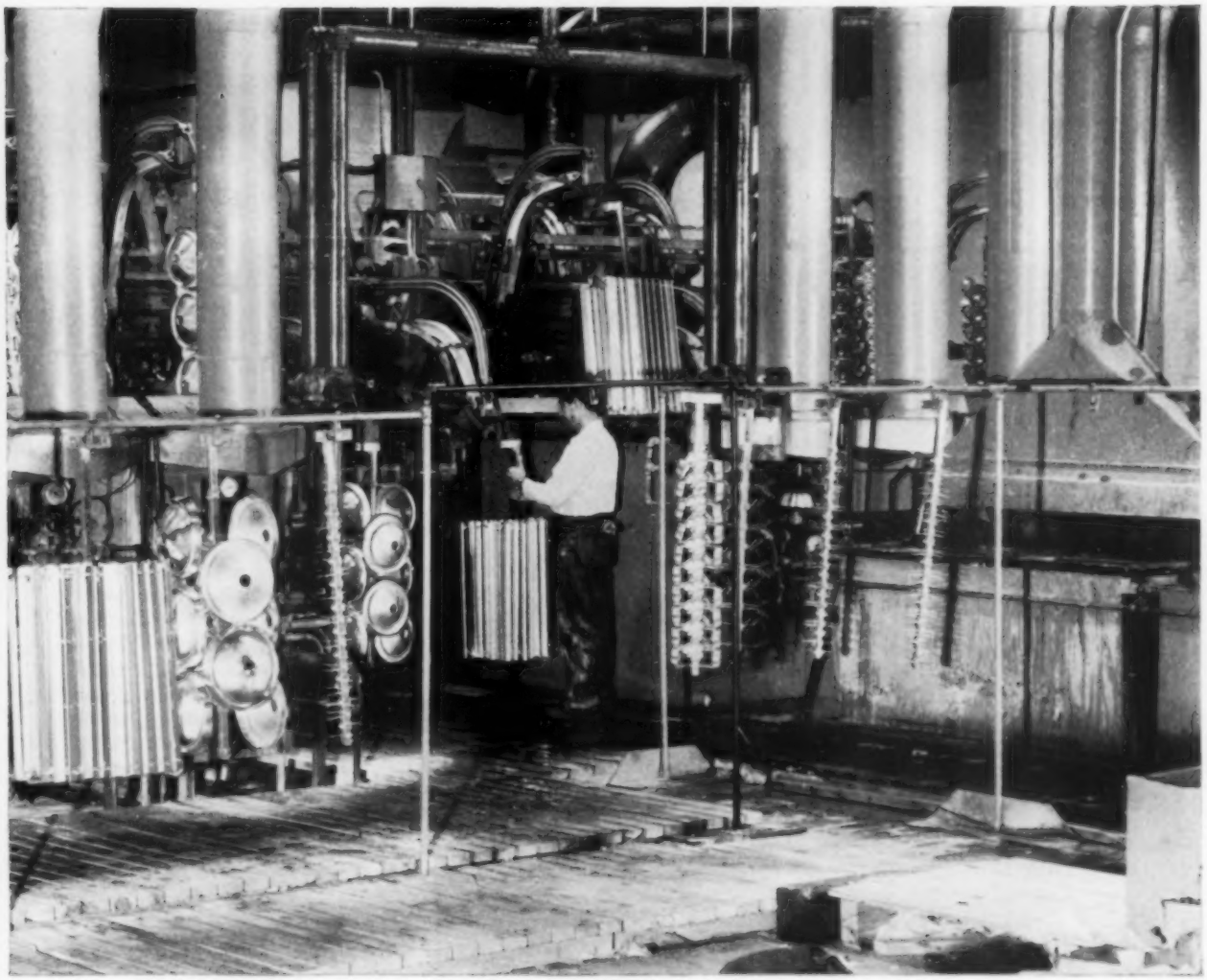

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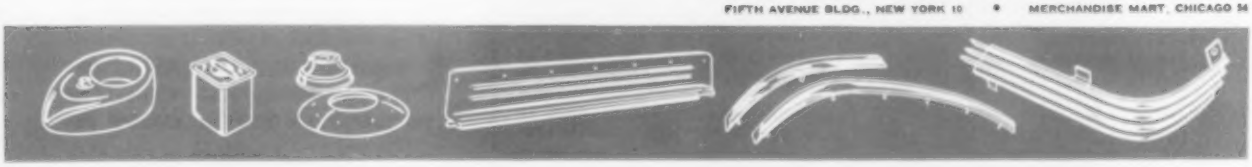

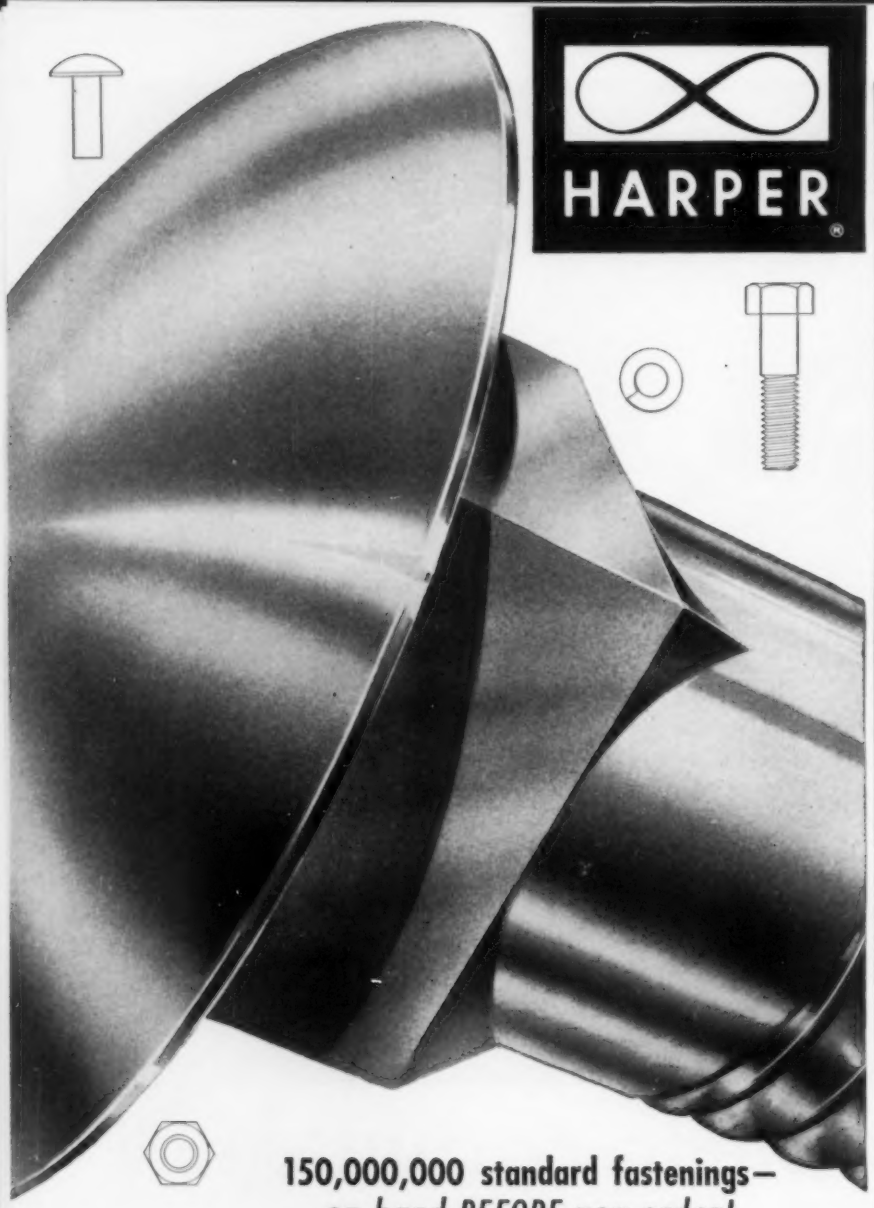

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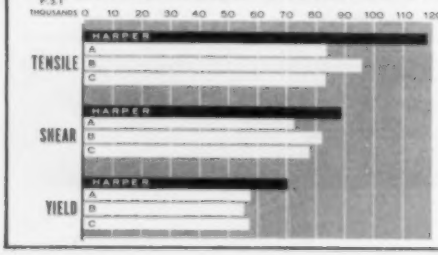


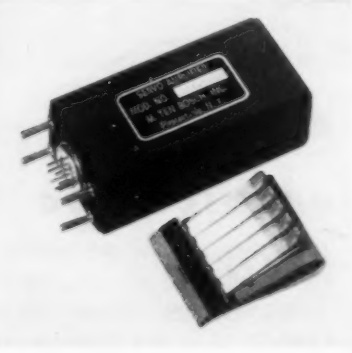
An important point in buying fastenings is strength. Independent laboratory tests*, utilizing Stainless Steel Machine Bolts by Harper and three other leading producers, prove Harper superiority in Tensile, Shear, and Yield Strength. The chart at left shows the actual results of these tests. For complete information on these important tests, request Form No. 126.

*By R. W. Hunt Laboratories

rising pulse suitable for driving the binary counter and other circuits. A-c and d-c inputs are provided. A nominal delay circuit is designed to provide delayed feedback or reset pulses. Delay time can be extended externally.

A follower amplifier has a circuit which can be coupled directly to transistor counter outputs and is primarily employed to provide usable counter output without loading counters. Walkirt Co., 141 W. Hazel St., Inglewood, Calif.

For more information—
Circle 54, inside back cover



Miniature Servo Amplifier

This hermetically-sealed, plug-in transistor-equipped servo amplifier is primarily intended to receive signals from a synchro control transformer and to operate a Size 15, 400 cps, 6.1 w servo motor or equivalent. Size is $1\frac{7}{16}$ x $1\frac{11}{16}$ x $3\frac{11}{16}$ in. high. Weight is 7 oz.

Input Impedance (Nominal) is 10,000 ohms; Voltage gain 1600 at 6 w output. Phase Shift is adjusted in-

(Continued on page 257)

ternally to provide essentially zero phase shift. Input-Power Requirements are 100 v d-c at 100 ma; 28 v d-c at 12 ma. M. Ten Bosch, Inc., Pleasantville, N. Y.

For more information—
Circle 55, inside back cover

Changes Phase and Voltage

The machine converts single-phase, 115 v, 60-cps a-c to three-phase, 230 v, 60-cps current. Frequency is held constant within a fraction of a cycle from no-load to full load. The machine is rated at 500 w and weighs 37 lb. The unit is 8½ x 9 x 10 in. long. Kato Engineering Co., Mankato, Minn.

For more information—
Circle 56, inside back cover

Miniature Wire Clamp

Designed to secure wire bundles in limited-space electronic equipment, this plastic clamp withstands impact loads better than 50 b. Installation of wire involves two operations—placing the wire inside the U-shaped clamp, and manually pushing a keeper over

(Continued on page 258)

HARPER

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Harper FLO-FORM Process
Saved money...made part better!

A manufacturer of an electrical hand tool was milling and slotting a copper conductivity pin from wire. The cost was too high—too many rejects. They called in the Harper Application Engineer who suggested redesign of the part for production by the Flo-Form Process. Now it is made at lower cost. There are no rejects. Grain structure is better. The part is stronger and more efficient. Your "special" problem can be solved by the Harper Flo-Form engineering team of designers, metallurgists, and tooling specialists with vast experience gained in over 33 years of solving fastenings problems. Save money. Send us your problem today or call your nearby Harper Branch for Harper Application Engineering Service.

Meet ALBERT ROTH,
Harper Application Engineer

Working out of Denver through the Rocky Mountain area, Harper Application Engineering Service is extended to fastening users by Mr. Roth. Al works with the Harper Flo-Form Engineering Team to provide fastening users with better designed parts at lowest possible costs.

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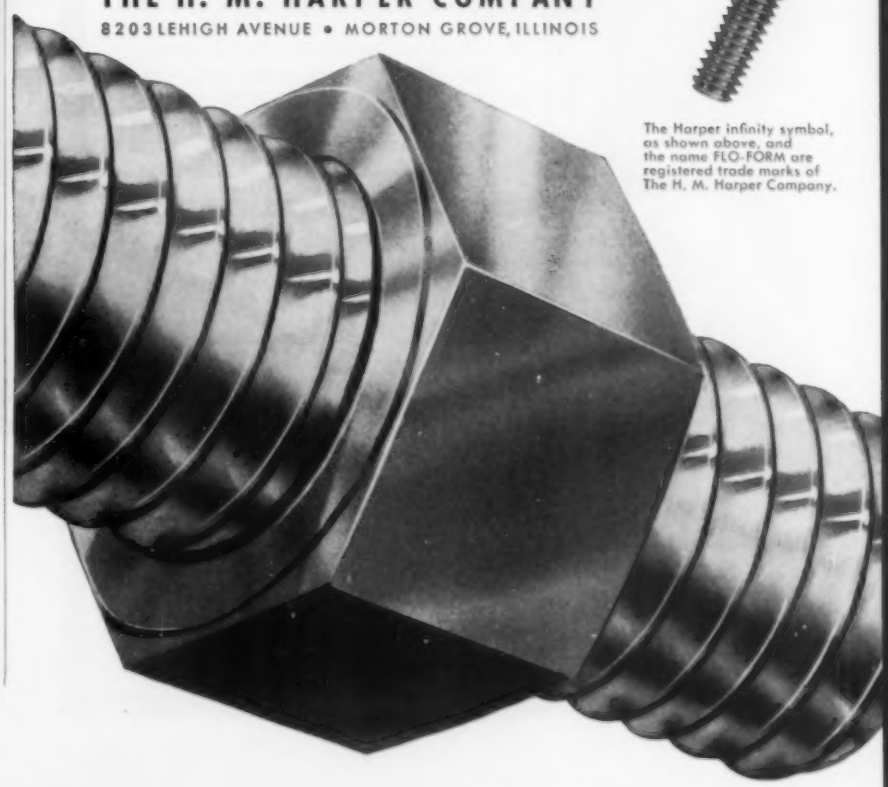

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ROTARY ACTUATORS • SPECIAL CONTROLS

the notched edges, where it locks with high holding power. No tools are required, and tying is eliminated. Clamps may be released for adding or removing wires.

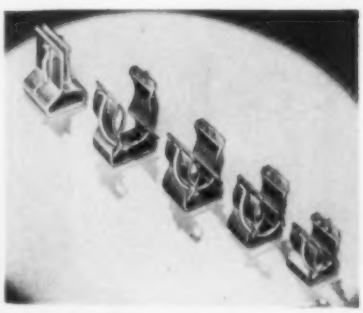
Units are available in sizes starting at ⅛ in., weighing 0.001 lb., and extend to a 2½ in. size; weighing 0.052 lb. Dakota Engineering, Inc., 6641 Crenshaw Blvd., Los Angeles 43, Calif.

For more information—
Circle 57, inside back cover

Silicon Diodes

A series of silicon diodes capable of operation at 375 C and storage at 400 C covers a current rage of 100 milliamp to 1 amp. United States Dynamics Corp., 1250 Columbus Ave., Boston, Mass.

For more information—
Circle 58, inside back cover



Wire-Reinforced Fuse Clips

Made of 100% electrolytic copper, these clips and jaws are said to provide greater conductivity with a lower heat rise, outperforming any alloy clip available today. Steel wire reinforcing permits fuses to withstand excessive

(Continued on page 262)

EXTRA HEAVY DUTY

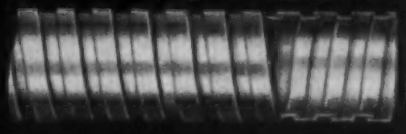
HEAVY DUTY

LIGHT DUTY

MEDIUM DUTY

PENFLEX

LIGHTWEIGHT EXHAUST



SQUARE LOCKED CASING

RUGGED FLEXIBILITY

FOR EVERY INDUSTRY'S REQUIREMENTS

Tough as a pipe, but flexible, that is Penflex tubing. You name your need for conveying volatiles, liquids, chemicals, powders, granular materials, or semi-solids . . . hot or cold . . . and Penflex has the right tubing to provide the maximum service. It is unsurpassed for withstanding rough abuse, abrasion, crushing and heat.

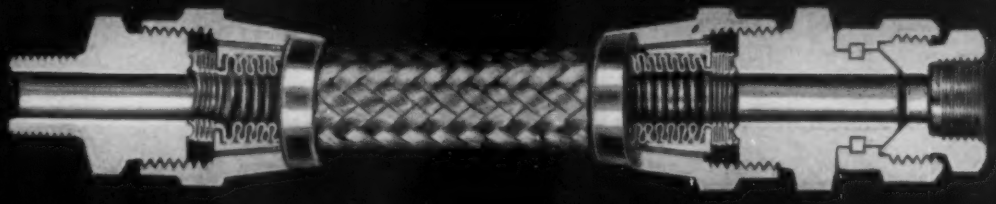
Squarelocked, interlocked, corrugated . . . packed or unpacked . . . braided or unbraided . . . with all types of couplings. Penflex makes them to meet your exact specifications and scientifically engineers them to the installation with "Flexineering." If you need flexible metal tubing from ⅛" to 24" I.D. . . . bronze, galvanized or stainless steel call on your Penflex man. For data on the complete line of products . . . plus valuable specifications on flexible tubing write for your copy of "Flexineering."

PENNSYLVANIA FLEXIBLE METALLIC TUBING COMPANY, INC.

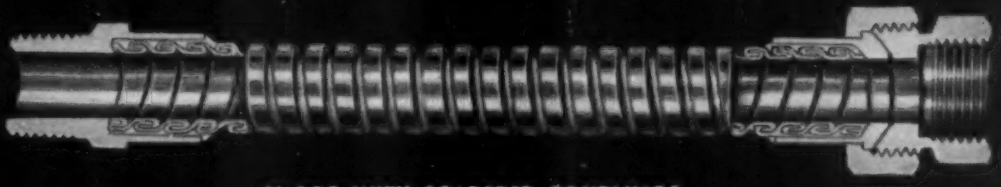
7239 POWERS LANE, PHILADELPHIA 42, PA.

Branch Sales Offices: Boston New York Chicago Houston Cleveland Los Angeles

and Distributors in Principal Cities



PENFLEXWELD WITH HEATPROOF COUPLINGS



M-100 WITH SOLDERED COUPLINGS

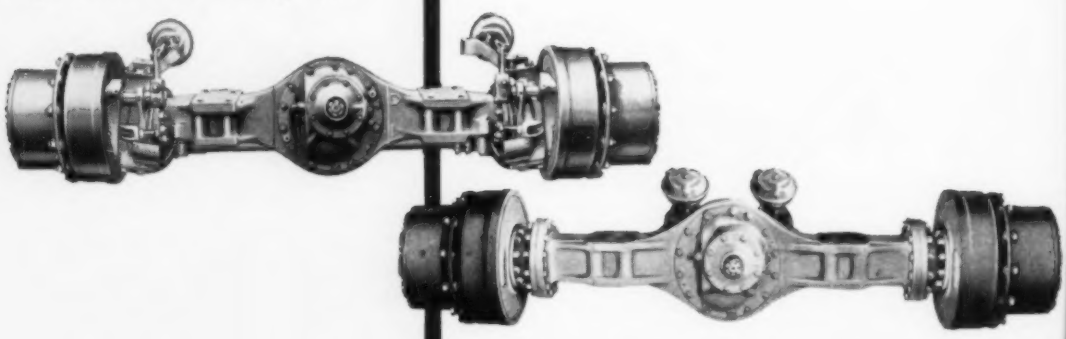
To designers and builders of heavy-duty off-highway vehicles.

TIMKEN-DETROIT® OFFERS today's broadest range of planetary axles

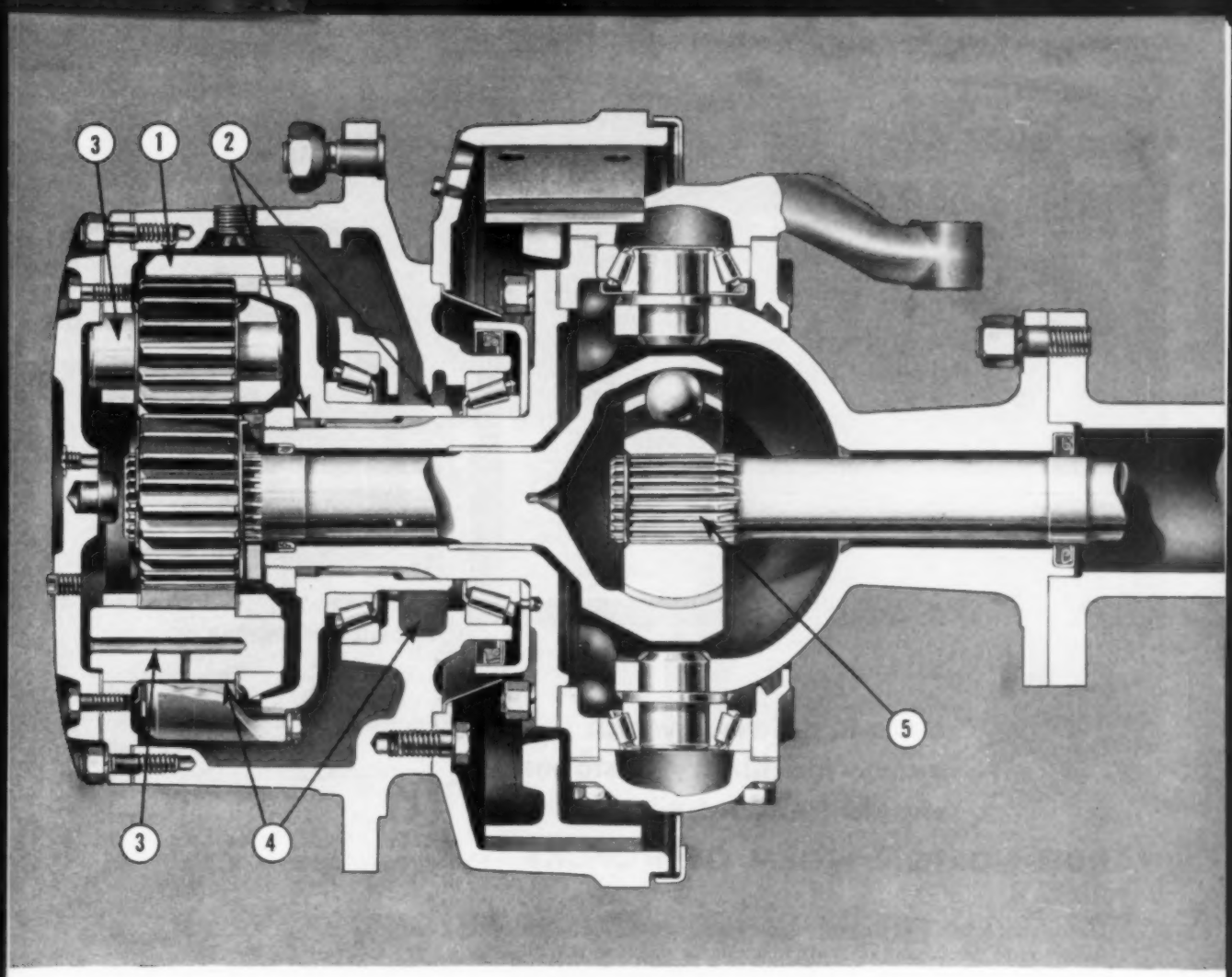
Timken® pioneered planetary axles for heavy-duty applications. And today, the TDA® family of advanced design axles includes a complete range of new planetary heavy-duty axles . . . with a steering axle operationally matched to each rigid axle in the line. They are backed by 50 years of design, engineering and manufacturing leadership . . . plus constant field testing, laboratory research and development.

Only New Timken Full Planetary Design Brings You All These Features for Extra-Long Life, and Extra Dependability!

1 Floating Ring Gear and hub are two separate pieces. Combined with floating sun gear, this feature assures equal distribution of stresses to all planetary gears, gives longer, trouble-free gear life.



WORLD'S LARGEST MANUFACTURER OF AXLES



2 Concentrically Ground Ring Gear Hub and Spindle Mounting Surfaces assure perfect alignment—plus freedom from bending forces on the hub and spindle splines. Splines absorb only torsional stresses from the ring gear.

3 Special Forged Bronze Planet Pinion Pins of premium alloy bronze for longer, trouble-free operation. Rifle drilled lubrication channels and machined lubrication flats assure full time lubrication. Pin is locked in place by cover to prevent rotation. This results in longer pin life.

4 Full-Flow Oil Lubrication of Planetary Outer End assures constant flow of lubricants to wheel bearings and all planet gears. When vehicle is not in motion oil is retained in cast reservoirs to provide ample initial lubrication.

5 New Axle Spline Design with a greater root diameter and more splines per shaft decreases individual spline load for longer, more dependable operating life. Splines at differential are enveloped by side gears to give uniform stress distribution.

Timken High-Traction® Differential automatically compensates for the loss of traction of one driving wheel by transmitting additional power to the other driving wheel having traction. This unit operates equally well in either forward or reverse. (Available as optional equipment.)

High Degree of Parts Interchangeability between both rigid and steering axles in the same series. This means smaller parts inventory, low maintenance costs and more productive work time with Timken Planetary equipped vehicles.

Plants at: Detroit, Michigan • Oshkosh, Wisconsin
Utica, New York • Ashtabula, Kenton and Newark, Ohio
New Castle, Pennsylvania

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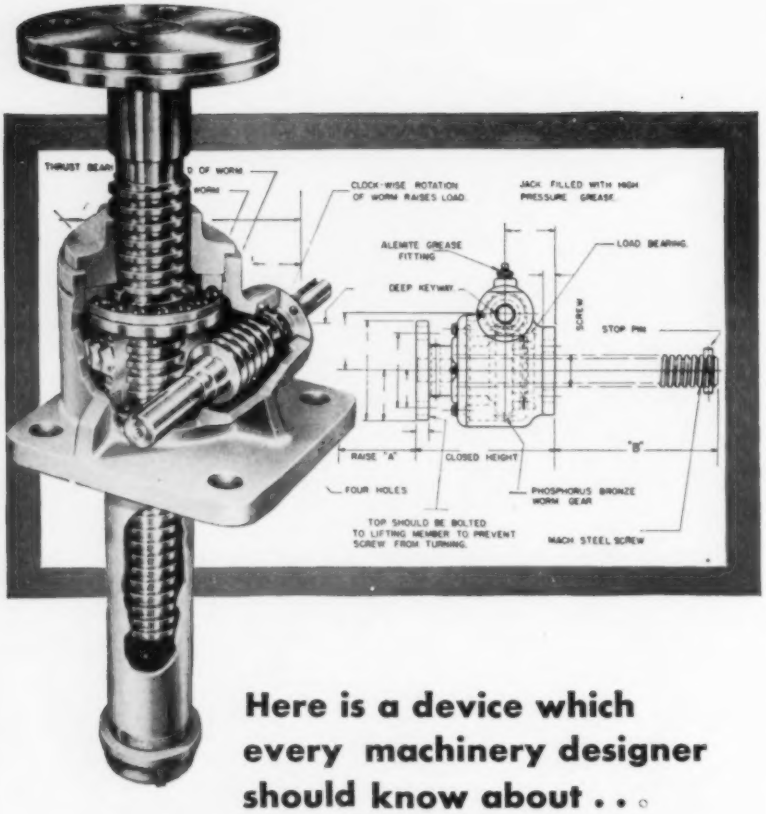
TIMKEN Detroit AXLES
TIMKEN-DETROIT AXLE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
DETROIT 32, MICHIGAN
The Accepted D A Standard
TRADE MARK REGISTERED

FOR TRUCKS, BUSSES AND TRAILERS



Here is a device which every machinery designer should know about . . .

DUFF-NORTON WORM GEAR JACKS

Duff-Norton worm gear jacks provide a purely mechanical means for accurate positioning of loads weighing as much as several hundred tons and maintaining them indefinitely without creep. They will operate in any position, and functioning as components of machinery and equipment they can raise and lower loads, apply pressure or resist impact. Jack capacities range from five to 50 tons. When two or more jacks are connected by means of shafting and mitre gear boxes they lift in unison, even when the load is unevenly distributed. They are available with standard raises up to 25 inches, and will provide exactly the same raise for years without adjustment. Worm gear jacks are suitable for operation at ambient temperatures up to 200°F.

Thousands of these jacks are in use on feeding tables, tube mills, welding positioners, pipe cut-off and threading machines, testing equipment, aircraft jigs, loading platforms, rolling mills, conveyor lines, arbor presses, and numerous other types of equipment. If you have a positioning problem, write for complete information, requesting bull. AD-34-DD, which includes drawings and full specifications.

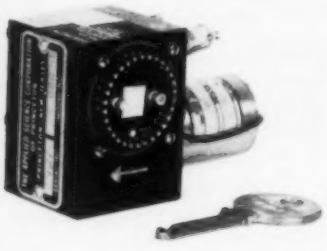
DUFF-NORTON **Duff-Norton Jacks**

DUFF-NORTON COMPANY
P. O. Box 1889 • Pittsburgh 30, Pennsylvania
COFFING HOIST DIVISION: Danville, Illinois

Ratchet Jacks, Screw Jacks, Hydraulic Jacks, Special Worm Gear Jacks, Ratchet Hoists, Electric Hoists, Load Binders, Spur Gear Hoists

vibration and shock. The clips are available in the following sizes 30 amp, 250 v; 30 amp, 600 v; 60 amp, 250 v; 60 amp, 600 v; 100 amp, 250 v. Dept. M. Ilsco Corp., Cincinnati 27, Ohio.

For more information—
Circle 59, inside back cover



Miniature Sampling Switch

Weighting 7 oz and measuring 2⅛ x 1⅛ x 1⅛ in. wide, this two-pole, 30-contacts per-hole switch will provide 60 channels in make-before-break operation. A filtered 27.5 v d-c motor rotates the switch at 2.5 rps providing a sampling rate of 150 samples per second. Applied Science Corp. of Princeton, Princeton, N. J.

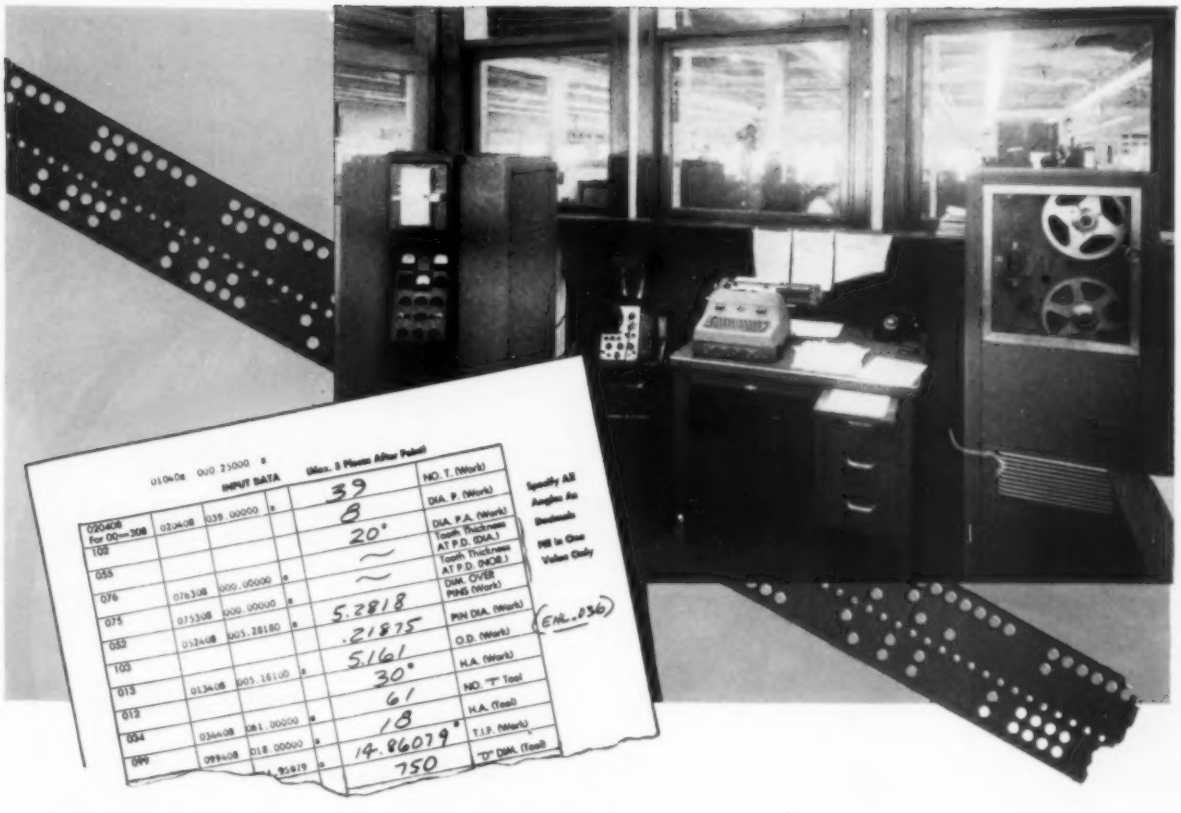
For more information—
Circle 60, inside back cover

Indicating Pyrometers

These medium resistance pyrometers (4 ohms per milliv) are available in 21 standard ranges. Maximum sensitivity for a pyrometer connected to one thermocouple is 300 F for full scale deflection. Standard ranges begin with −400 to 100 F and go up to 0 to 3000 F.

Full scale accuracy of 2% is standard, although 1% may be obtained. These pyrometers may be thermistor-compensated. Styles available include panel mounting, portable and bench

(Continued on page 266)



COMPUTER TECHNIQUES
solve special gear and cutter designs

Giving designers exceptional freedom in their specifications for special gears to improve design, the electronic computer easily makes the calculations necessary for making cutting tools to meet the most critical requirements. This high-speed Bendix Computer shortens hours of calculation to minutes, permitting complete mathematical study of complex problems.

A punched tape holds the basic formulae, the computer program. Variables for a particular Fellows Cutter, Shaving Tool, or Master Gear are typed on an electric typewriter which feeds them into the computer. As fast as the operator can type, the computer does the figuring which used to require hours of labor.

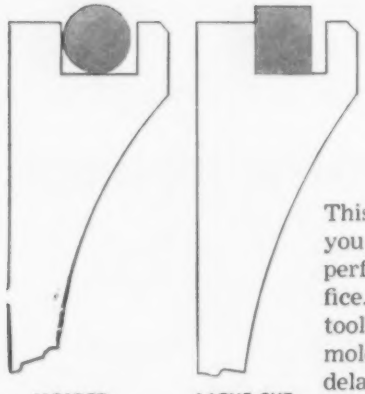
Fellows Gear Shapers tooled with Fellows Cutters lower costs and speed production on internal and external spur, helical and herringbone gears. Many examples of interest to designers are shown in the booklet, "The Art of Generating with a Reciprocating Tool." Just write any Fellows office for your copy.

THE FELLOWS GEAR SHAPER COMPANY
78 River Street, Springfield, Vermont
Branch Offices:
1048 North Woodward Ave., Royal Oak, Mich.
150 West Pleasant Ave., Maywood, N.J.
5835 West North Avenue, Chicago 39
6214 West Manchester Ave., Los Angeles 45

THE PRECISION LINE *Fellows* *Gear Production Equipment*

Why ACADIA LATHE-CUT SYNTHETIC RUBBER SEALS

can save you money in *STATIC* or *MOVING* seal applications



MOLDED O-RING SEAL

LATHE-CUT SEAL

This seal will save you money with no performance sacrifice. Minimum tooling cost, no molds, no costly delays. Can be made up to 25″ I.D.

Acadia Synthetic Rubber Parts are of the highest quality components, processed for oil resistance, good aging properties, resistance to heat. They can be furnished in any dimension or special compound you desire to precision tolerances. They are another example of Acadia's ability to SAVE YOU MORE..SERVE YOU BETTER.

There's an Acadia Sales engineer near you to serve you. Write us today, and we'll put him in touch with you immediately.

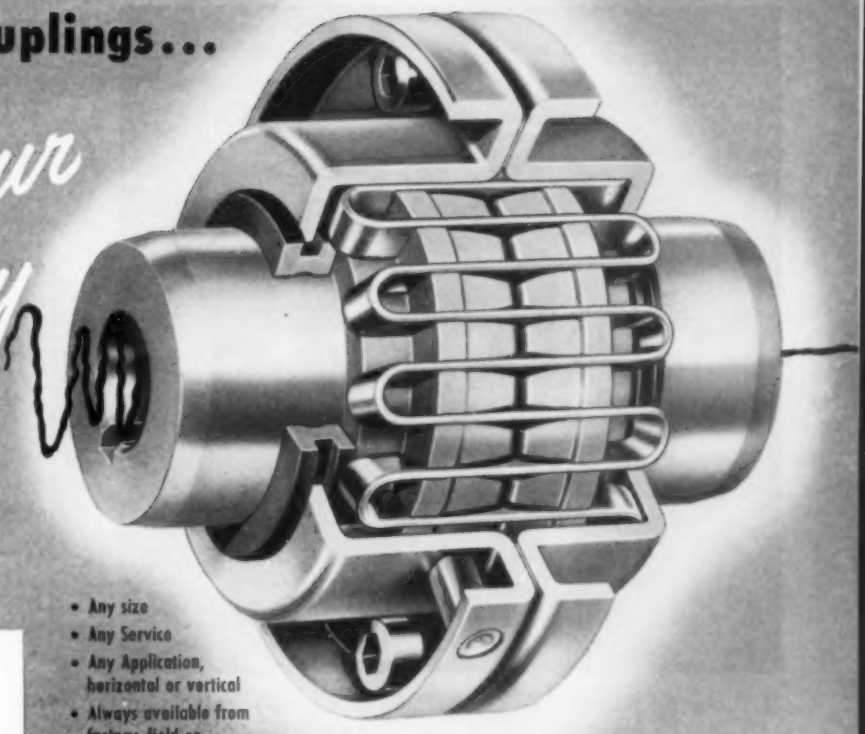
ACADIA *Synthetic* **PRODUCTS**

DIVISION OF WESTERN FELT WORKS
4021-4139 West Ogden Avenue, Chicago 23, Illinois
Branch Offices in Principal Cities

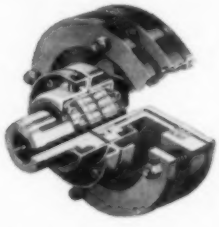
MANUFACTURERS AND CUTTERS OF WOOL FELT

Falk Steelflex Couplings...

Protect your machinery in 2 ways



- Any size
- Any Service
- Any Application, horizontal or vertical
- Always available from factory, field or distributor stocks

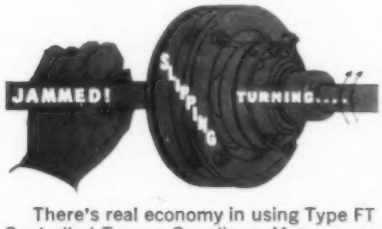


Falk Controlled Torque Couplings prevent damage from overloads

In applications where danger from overloads exists, use the FALK Type FT Controlled Torque Coupling. The Type FT has all the features and advantages of standard FALK Steelflex couplings—and, in addition, has an adjustable friction slip clutch, enabling the operator to set the coupling to slip at any predetermined overload.

This controlled-torque principle not only prevents transmission of dangerous shocks and limits overloads; it eliminates the breaking of shafts caused by jamming of driven equipment.

An outstanding advantage of the Type FT Coupling is that, as soon as the cause of the overload is removed, the entire coupling will rotate and transmit power without replacing parts or repairing coupling.



There's real economy in using Type FT Controlled Torque Couplings. Many users have reported that these couplings paid for themselves the very first time they slipped (under overload) because of the protection against damaged driving or driven machinery!

...cost less per year of service!

You get *double protection* when you connect your driving and driven machinery with a Falk Steelflex Coupling—the all-steel coupling with the exclusive grid-groove design! First, its *torsional resilience* smothers shock and vibration; and second, the Steelflex design prevents damage and lowered efficiency by accommodating shaft misalignment.

Why have increasing numbers of key men in industry standardized on Falk Steelflex Couplings? Their experience has proved that Falk Steelflex Couplings prolong the service life of their machinery... are trouble-free and need minimum maintenance... are easy to install, lubricate and disconnect... and *cost less per year of service* than ordinary couplings.

One basic Steelflex design—the type F, in its many sizes—is adaptable to more than 90% of all industrial applications. For applications involving danger from overloads, Modified Type FT Controlled Torque couplings (see column at left) are ideally suited. There are numerous other special or dual purpose Steelflex couplings for unusual applications. **Write to Department 247** for engineering bulletin, including selection and dimension tables.

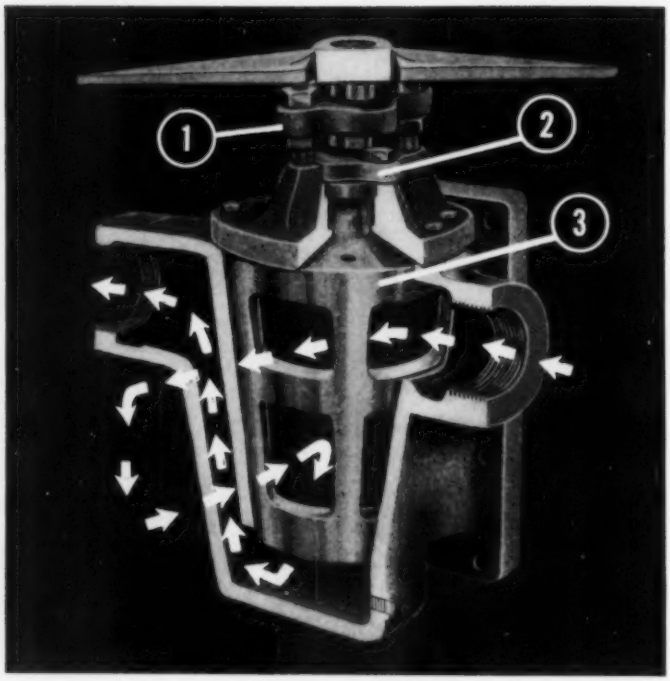
THE FALK CORPORATION, MILWAUKEE, WISCONSIN

FALK

...a good name in industry

MANUFACTURERS OF:

- Motoreducers
- Speed Reducers
- Flexible Couplings
- Shaft Mounted Drives
- High Speed Drives
- Special Gear Drives
- Single Helical Gears
- Herringbone Gears
- Marine Drives
- Steel Castings
- Weldments
- Contract Machining



(1) Locking flange (2) Gland (3) Valve plug

NEW! Kraissl Class 72 Valve Simplifies Control of Non-Interrupted Flow

Originally designed and job-proven as the center section of our own Class 72 separator, this valve permits diversion of 2-way flow from one chamber to another—***without shutting down.*** The single-unit installation eliminates costly, cumbersome piping and fittings.

Simple, hand-turning of tapered, non-wedging valve plug re-routes flow into alternate chamber of system. Continuous-flow design of valve plug ***absolutely insures against shut-off.*** The Class 72 valve assembly is ideal for heat exchanger and similar applications where uninterrupted flow is mandatory.

Pressure ratings to 600 psig with standard line; Special valves for higher pressures.

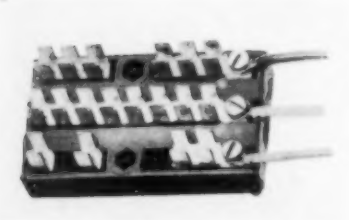
Write for technical bulletin A-1869

KRAISSL CO

289 Williams Ave. Hackensack, N. J.

models. Meters are 3¾ and 4½ in. wide. Assembly Products, Inc., Chesterland, Ohio.

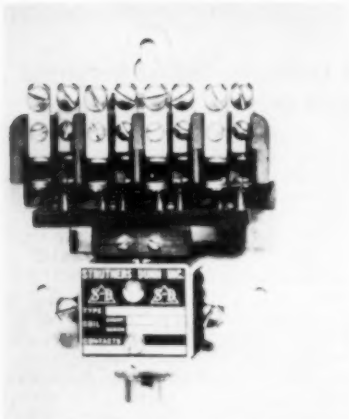
For more information—
Circle 61, inside back cover



Terminal Blocks

Molded of UL-approved plastic, the terminal blocks are available in infinite sizes, shapes and terminal arrangements to meet multiple circuit requirements. The blocks accept standard female terminal connectors. Model 665 also provides binding screws for incoming feed attachment. Molex Products Co., 9515 Southview Ave., Brookfield, Ill.

For more information—
Circle 62, inside back cover



Three and Four-Pole A-c Contactors

These contactors are for the control of a-c motors, solenoids, heaters and other loads. Single-throw double-break contacts are individually sprung to maintain contact alignment. Contacts are of fine silver in melamine arc chutes, with a safety factor under high overload conditions.

All coil and contact terminals are accessible from the front. Contacts are conservatively rated at 15 amp

(Continued on page 269)

bright future

Buildings constructed and decorated with Stainless Steel are cleaner, more attractive places to work and live. When you're planning a building . . . design it, improve it and protect it with McLOUTH STAINLESS STEEL.

specify

McLOUTH STAINLESS STEEL

HIGH QUALITY SHEET AND STRIP

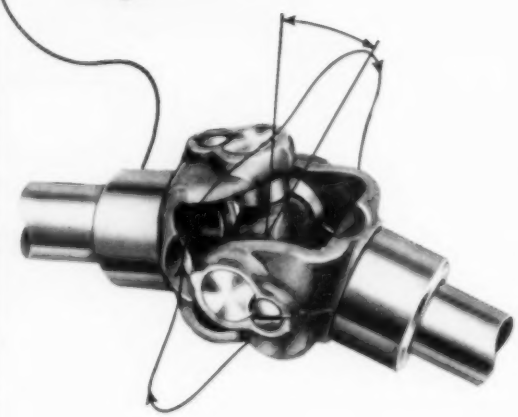
for architecture

McLOUTH STEEL CORPORATION DETROIT, MICHIGAN

MANUFACTURERS OF STAINLESS AND CARBON STEELS

THIS ACTION MAY HAVE A

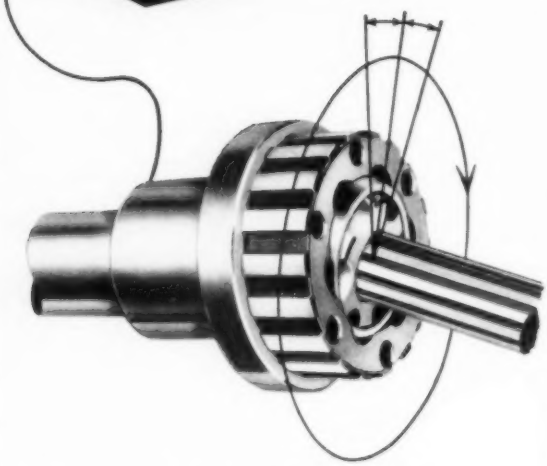
LOWER PRICE



Old-fashioned pin or slipper-type joints speed up, slow down twice during one revolution. This delivers rough "rock and roll" torque which results in greater vibration and wear. They must employ clumsy additional mechanisms to compensate for their unbalanced action at extreme angles.*

THIS ACTION ALWAYS HAS A

LOWER COST



Rzeppa Joints *always* transmit smooth "full power" torque at angles as much as 35°! Ball bearings—located in a plane bisecting the angle between driving and driven members—deliver smooth rotation, eliminating wear and vibration. Constant velocity means longer joint and shaft life, too.*

57A

RZEPPA

SHEPPA

CONSTANT VELOCITY UNIVERSAL JOINTS

The Gear Grinding Machine Company

3939 CHRISTOPHER, DETROIT 11, MICHIGAN

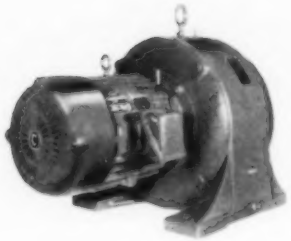
MANUFACTURERS OF: FULLY AUTOMATIC GEAR GRINDING MACHINES
DETROIT SCREWMATIC 750 SINGLE SPINDLE SCREW MACHINES

*HOW RZEPPA'S CONSTANT VELOCITY SAVES YOU MONEY. If a universal joint operates with less friction it wears longer; if it has a higher capacity it can produce more. Through the principle of constant velocity—shown above—Rzeppa delivers these cost-savings that are impossible with designs of lower price.

Send us a dimensional sketch along with peak horsepower, operating angles and R.P.Ms. Our engineers will assist in making a proper joint recommendation. WRITE FOR LATEST BROCHURE.

standard a-c voltages to 600 v. Horsepower ratings range from 3 hp for 440/550-v service and 2 hp for 110/220-v, two and three-phase service; to 1½ hp for 230 v and 1 hp for 115 v, single-phase service. Struthers-Dunn, Inc., Pitman, N. J.

For more information—
Circle 63, inside back cover



Low-speed Gearmotors

The gearmotors are available with polyphase, single-phase and d-c motors, with output speeds of 750 to 7.5 rpm. A variety of mounting positions is possible, including downshaft and tilted shaft. They can be obtained in open dripproof, dustproof, explosion-proof, and totally enclosed frames. Century Electric Co., 1806 Pine St., St. Louis 3, Mo.

For more information—
Circle 64, inside back cover

Indicator Lamps for Panel Mounting

The assemblies consist of 24 v slide base telephone switchboard type lamp, plug-in housing, tubular resistor, bezel and color caps supplied in red, green, amber, blue or white. Resistors sup-

(Continued on page 272)

NEW DESIGN FLEXIBILITY with VERSATILE IR PUMPS

FOR SIDEWALL MOUNTING

FOR IMMERSION

long-shaft, packingless pumps improve handling of coolant, cutting oils and washing liquids.

High production machines like grinders, lathes, drills, etc., industrial washers or spray bath machines depend on their integral components for sustained, trouble-free operation. This is why these Ingersoll-Rand Motorpumps are being recommended by design men everywhere.

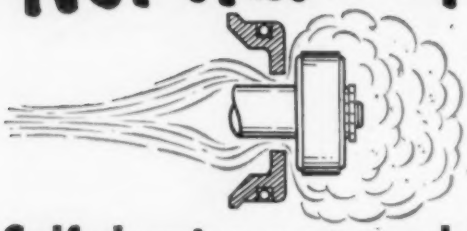
- Packingless – long life, less maintenance, no leaks.
- Long Shaft – higher liquid level, lower draw down.
- Motor Protection – vent hole near head prevents flooding.

Other compact Motorpumps are available in sizes ¼ hp to 75 hp. Get the interesting performance data on Ingersoll-Rand Centrifugal pumps now.

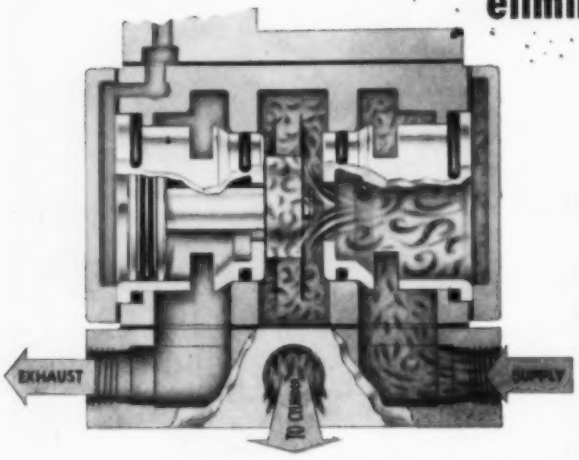
Ingersoll-Rand

9-488 11 Broadway, New York 4, N. Y.

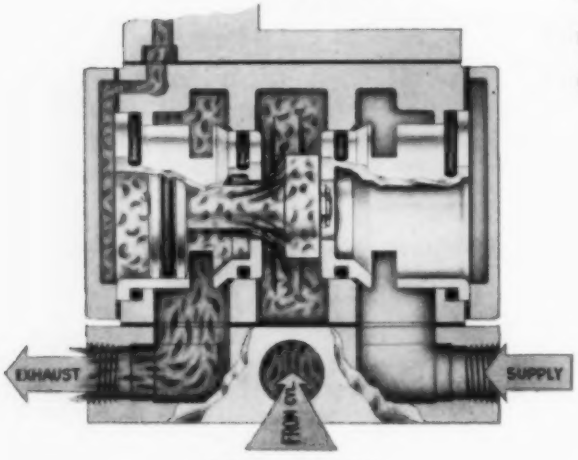
Not Hurt by Dirt! . . . Another Plus Value in NOPAK-MATIC air control valves



Self-cleaning seats prolong valve life, eliminate costly valve maintenance



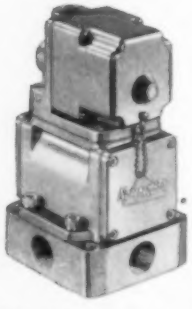
DE-ENERGIZED



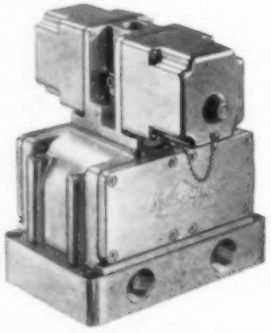
ENERGIZED

With each valve cycle, a blast of air crosses each poppet seat, keeping them free of harmful dirt. But exceptional tolerance to dirty air is only a small part of the Nopak-matic story. It also includes . . .

- **Exclusive "Flow-Director" pilot heads that mean extra versatility and ease of installation.**
- **100% J.I.C. conformance . . . at no extra cost.**
- **Complete pilot head interchangeability.**
- **Low-friction seals for long operating life.**
- **Fast-maintenance design.**
- **Compact, lightweight construction.**
- **Replaceable, self-cleaning seats.**
- **Choice of either side or bottom ported 4-Way.**
- **Split second response—Full flow.**



SERIES 310 — 2- or 3-Way
Single Solenoid Pilot Controlled
(maintained contact type)



SERIES 420 — 4-Way
Double Solenoid Pilot Controlled
(momentary contact type)

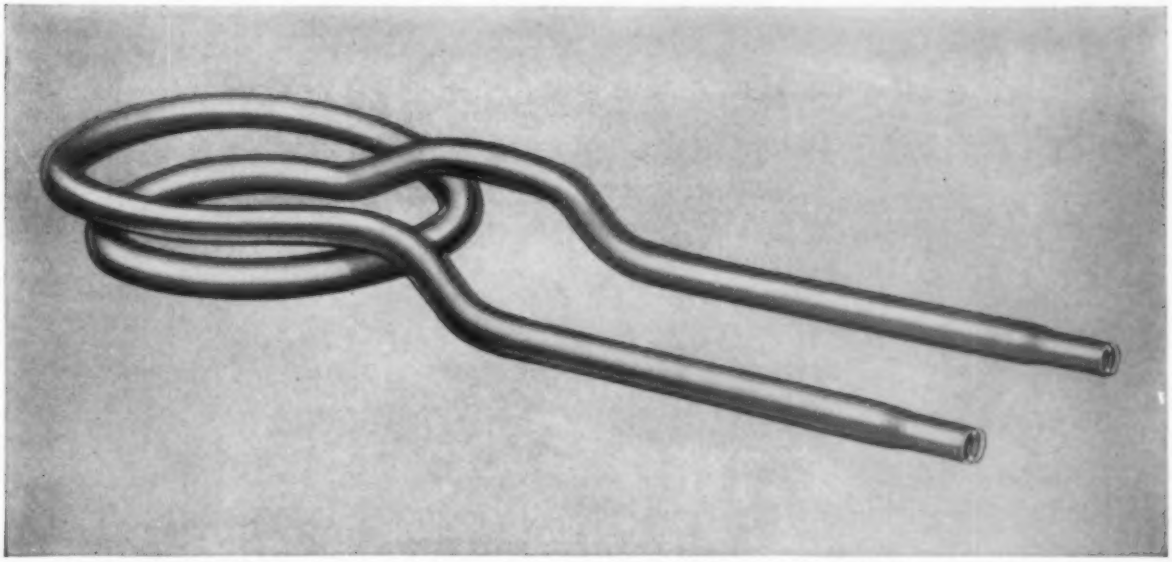
NOPAK-MATIC Plus Value Valves are available in ¼", ⅜", ½" and ¾" pipe sizes, for 2- or 3-Way Normally Open or Normally Closed or 4-Way operation with master (air), single or double solenoid pilot control heads.

NOPAK VALVES and CYLINDERS

GALLAND-HENNING NOPAK DIVISION • 2762 South 31st St. • Milwaukee 46, Wis.

Send for **Catalog 105** —it contains complete details of all Nopak-matic features, dimensions, installation data, and parts lists. Send now and your catalog will be forwarded promptly.

A6-604-1P



Complex shape of this oil-cooler tube lets it clear moving parts inside a compressor. Swaged ends are ready for brazing.

Bundy helps design a steel pretzel; bends it for Kelvinator compressor

Designing a compressor oil-cooler tube is tricky. It must bend like a pretzel to clear moving parts; stand up to punishing vibration indefinitely . . . yet be mass-produced quickly and economically. So when the problem arose, Kelvinator Division of American Motors Corp. consulted with the tubing experts—Bundy® design engineers.

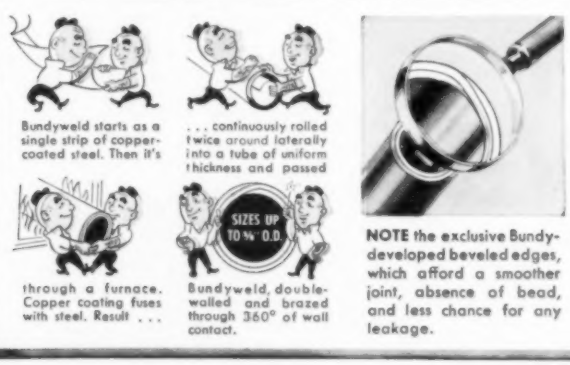
Working together, Kelvinator and Bundy designers carefully plotted the intricate bends needed for clearance within the compressor. Next, their design took form in Bundyweld® Tubing. Bundyweld is ductile enough for easy fabrication . . . strong enough to withstand vibration fatigue . . . yet costs less than the material used in previous designs. Finally, the job was turned over to Bundy's modern tubing-fabrication facilities for mass production.

This is but one of the countless problems solved by teamwork between Bundy and our customers in many industries. In addition to years of experience, we have the advantage of working with Bundyweld—the only small-diameter tubing made by the exclusive process shown below. *Leak-proof by test*, Bundyweld is the safety standard of the refrigeration and automotive industries . . . *is used on 95% of today's cars, in an average of 20 applications each.*

If you have tubing design or fabrication problems, Bundy has the answers. It will pay you to call, write, or wire us today!

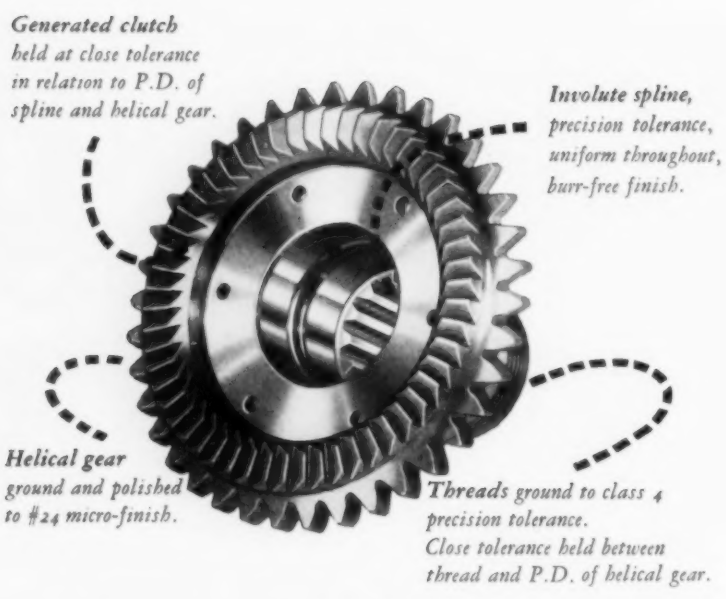
BUNDY TUBING COMPANY • DETROIT 14, MICHIGAN

WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING. AFFILIATED PLANTS IN AUSTRALIA, ENGLAND, FRANCE, GERMANY, AND ITALY


Bundyweld starts as a single strip of copper-coated steel. Then it's
. . . continuously rolled twice around laterally into a tube of uniform thickness and passed
through a furnace. Copper coating fuses with steel. Result . . .
SIZES UP TO ¾" O.D.
Bundyweld, double-walled and brazed through 360° of wall contact.
NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

BUNDYWELD® TUBING

DOUBLE-WALLED FROM A SINGLE STRIP



DON'T GAMBLE WITH GEAR PERFORMANCE

YOU know that gambling with gears can cost you money — production delays, costly rejects, failures in use. You don't want to take chances with your customers . . . they expect day-in, day-out performance from your machines. Your performance guarantee can be Perkins custom-cut gears . . . precision gears made to your exact specifications. Perkins' 52 years of gear-making know-how, extensive facilities and equipment, and rigid production controls assure uniform tolerances throughout . . .*plus* a consistent micro finish. You get perfect meshing and full capacity from every gear. Many leading manufacturers — Sikorsky, Stanley, Universal Winding, for example — rely on Perkins for top-quality gears, gears that cost less in the long run. Ask us to quote on your next gear requirement. Then judge for yourself.

YOURS ON REQUEST Folder illustrating gears Perkins has made — face gears, generated and curvic clutches; bevel, spiral, helical and spur gears; ratchets, sprockets and ground thread worms — from all materials. Includes Perkins facilities for producing various gear types and sizes. *Write today.*

PERKINS
MACHINE AND GEAR CO.

Dept. 22, West Springfield, Mass.
Telephone: REpublic 7-4751

plied make them suitable for operation on circuits up to 250 v.

Designed to be installed in $\frac{5}{8}$ in. holes in panels up to $\frac{1}{4}$ in. thick by removal of threaded bezel and color cap, terminals are suitable for No. 12 or smaller wire. Eastern Switchgear Div., Federal Pacific Electric Co., 888 N. Keyser Ave., Scranton, Pa.

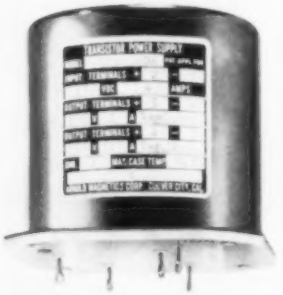
For more information—
Circle 65, inside back cover

Heating Element for Up to 550 F

A tubular, thin-walled, aluminum-encased heating element designed for low temperature applications operates at sheath temperatures up to 550 F, according to the manufacturer. Available in lengths up to 12 ft, the elements are encased in $\frac{1}{4}$ in., OD aluminum tubing. The element may be made up in a variety of shapes, including round, M or W designs. Reverse bends are available with radii as small as $\frac{3}{4}$ in. Circular shapes may be obtained with radii down to 1 in.

Terminals consist of insulated lead wires up to 24 in. Nickel chromium resistors are insulated with braided fiber-glass yarn. The resistors will withstand in excess of 1000 v from resistor to ground. Maximum watts density is $6\frac{1}{4}$ w per linear inch of effective heated surface. Acra Electric Corp., 9909 Pacific Ave., Franklin Park, Ill.

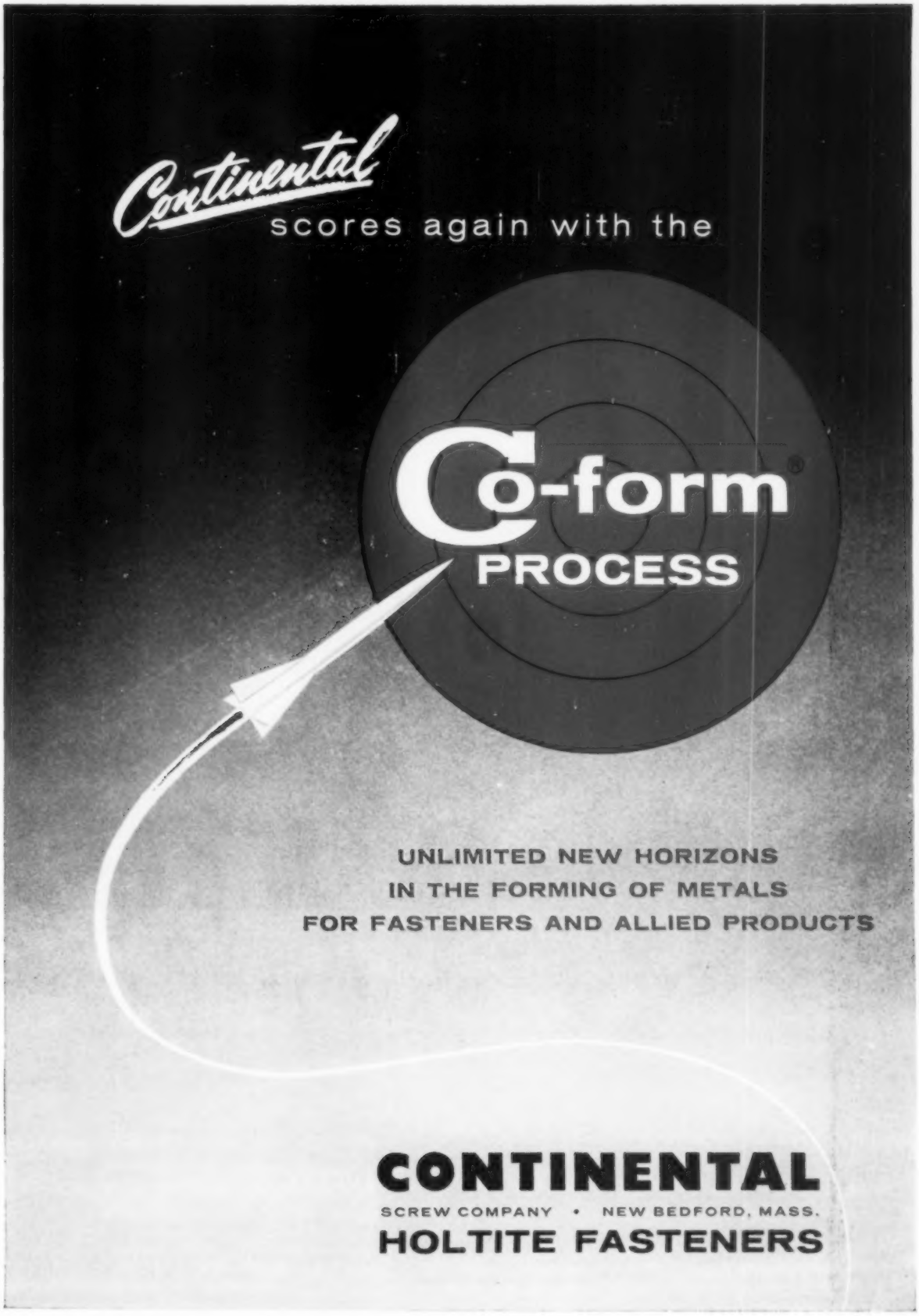
For more information—
Circle 66, inside back cover



Transistor-equipped Regulated Power Supply

This d-c to d-c power supply measures 3 x 3 in. high, and weighs 19 oz. It operates from an input of 24-30 v d-c. Outputs are available from 25 to 1200 v d-c, with power up to 60 w

(Continued on page 276)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scores again with the
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PROCESS
UNLIMITED NEW HORIZONS
IN THE FORMING OF METALS
FOR FASTENERS AND ALLIED PRODUCTS
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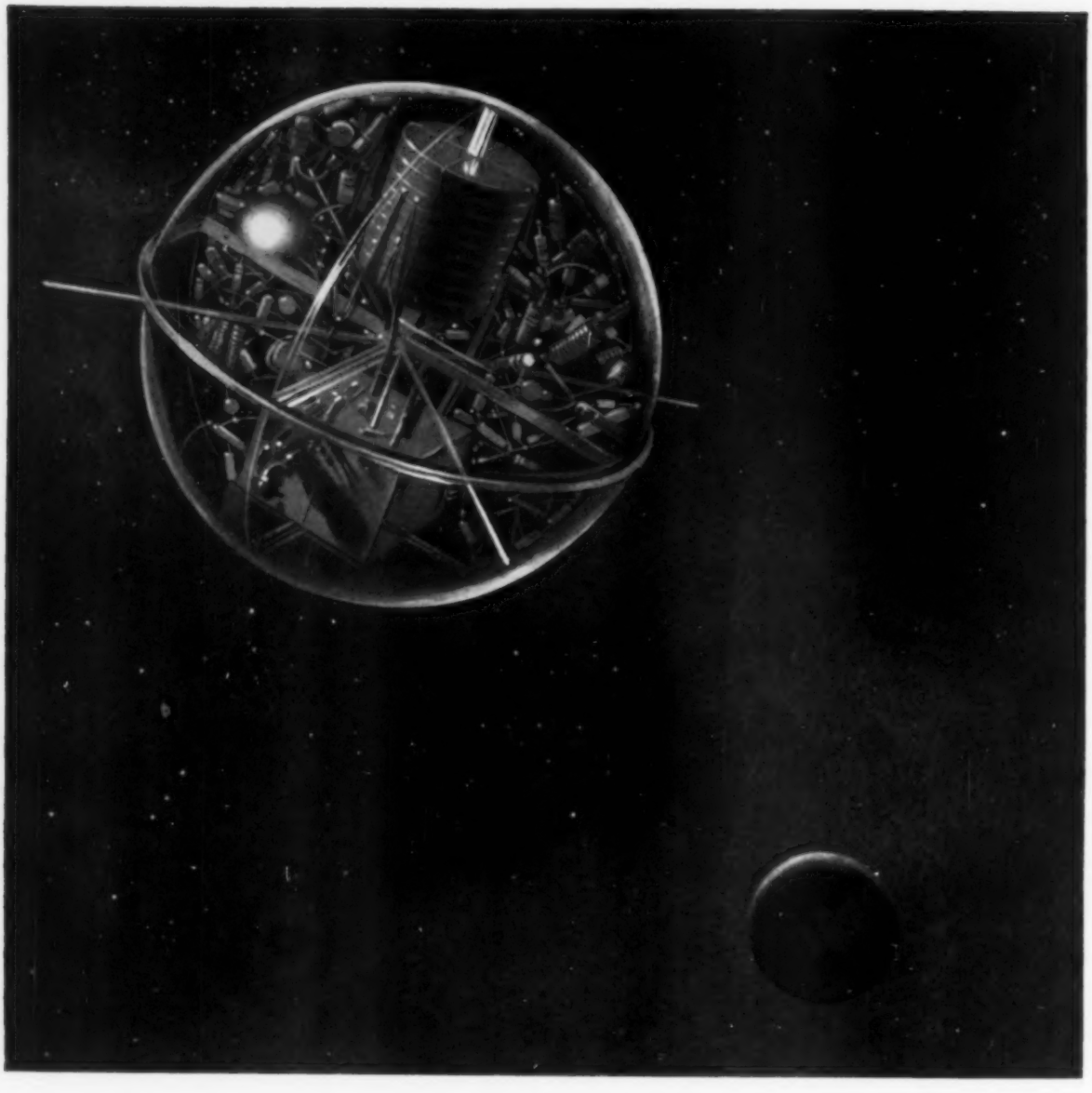

Putting a voice in the man-made moon

America's first man-made satellite will soon be launched into outer space where, traveling in its own orbit, it will circle the earth.

Deep inside will be sensitive electronic instruments which will "observe" cosmic activity and "report" findings back to us. Scientists believe that many a mystery of the universe may thus be solved.

Without electrical insulation of exceptional qualities, such as CDF supplies, the equipment inside these man-made moons could never operate.

FOR SPECIFIC INFORMATION on CDF products, see Sweet's, Electronics Buyers' Guide, and other directories. Then send us your print or your problem, and we'll return free samples and technical literature.

CDF MAKES Dilecto Laminated Plastics • Celoron and Polyester-Glass Molded Plastics • Micabond Mica Products • Diamond Vulcanized Fibre • Flexible Tapes of Teflon*, Silicone, and Micabond • Resin-Impregnated Spiral Tubing • *Complete Fabrication Facilities.*

*duPont trademark for its tetrafluoroethylene resin

CDF **CONTINENTAL-DIAMOND FIBRE**

A SUBSIDIARY OF THE Budd COMPANY • NEWARK 40, DEL.

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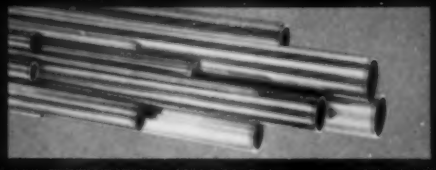
copper or
copper base
alloy tubing
remember

TEMPER

it should
be tuned
to the task!



The right temper for the task can mean the difference between success or failure, profit or loss. But, relax! Whatever your requirements, specify United seamless copper or copper base alloy tubing. Do so with confidence that the industry's finest quality and production control systems will deliver tubing drawn precisely to your specifications . . . for temper, size, gauge, grain structure, cleanliness, dimensional perfection and cost!

You pay no more for this quality! United tubing, the finest in copper and copper base alloy, is available in coils, straight mill lengths or cut to your specifications.

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BRANCH OFFICES IN DAYTON, OHIO, WASHINGTON, D. C. and TORONTO, ONT., CAN.

continuous duty. Arnold Magnetics Corp., 4613 W. Jefferson Blvd., Los Angeles 16, Calif.

For more information—
Circle 67, inside back cover

Hermetically Sealed Mercury Switch

This switch consists of a cylindrical glass envelope with metallic end caps, containing a pair of electrodes and a pool of pure mercury. One electrode is attached to each cap. The electrode ends are close together at one end of the tube and when the switch is tilted in that direction the mercury flows and bridges the gap between them to close a circuit. When tilted in the opposite direction, the mercury flows away to restore the gap, thereby, opening a circuit.

The device measures 1⅛ x ⅜ in. dia and weighs 0.16 oz. Contact position is readily visible. Electrical rating: single-pole, single-throw, 1.75 amp, 115 v; 0.6 amp, 230 v. Mercoid Corp., 4201 Belmont Ave., Chicago 41, Ill.

For more information—
Circle 68, inside back cover

Permanent Magnet Motor With Brake

A 1¼ in. motor with gear reduction is rated for continuous duty and is equipped with a positive action brake. Motor, brake and gear train is combined into a single, integral unit. Coast of output shaft is reduced to 2½° max from no-load speed at 30

(Continued on page 280)

Illustrated—New 9700 Series
Piggy Back Hydraulic Control Valve.

Look to Logan

the ultimate in hydraulic valve design

FREE SEND FOR THE "LOGAN CALCULATOR"
A gift to you from Logansport Machine Company upon request.

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PRODUCT ENGINEERING *styrene to glass with industrial adhesives*

This seemingly impossible production bonding problem (styrene-to-glass without discoloration or solvent attack) was solved by Terre Haute Advertising Company, Terre Haute, Indiana, with a 100% solids epoxy paste — BONDMASTER M653.

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INDUSTRIAL ADHESIVES

Bondmaster®

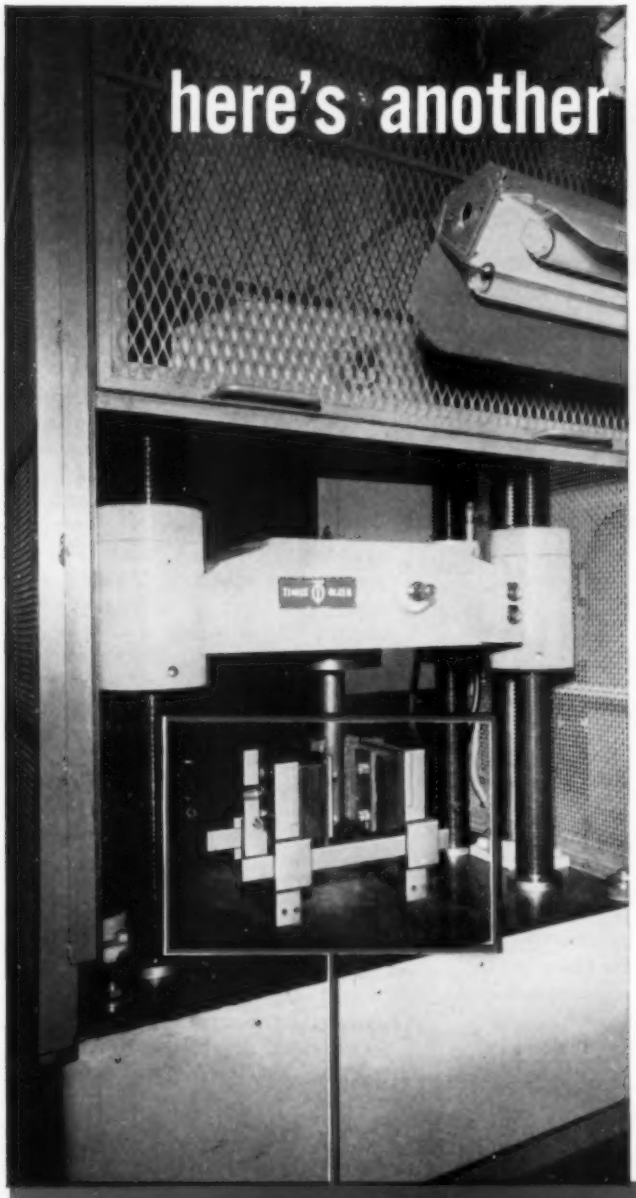
Adhesives

for plastics and metals

The flexibilized epoxy adhesive which enabled this attractive desk thermometer to be mass produced wasn't "custom formulated" for the job. It is one of more than 30 "stock" metal-and-plastics-to-themselves-and-to-each-other adhesives in the varied BONDMASTER line.

Send for free Adhesive Comparison Chart . . . and if one of these 30 doesn't provide the answer, we'll gladly formulate specially for your specific needs.

RUBBER & ASBESTOS CORP.
235 BELLEVILLE AVE., BLOOMFIELD, N.J.

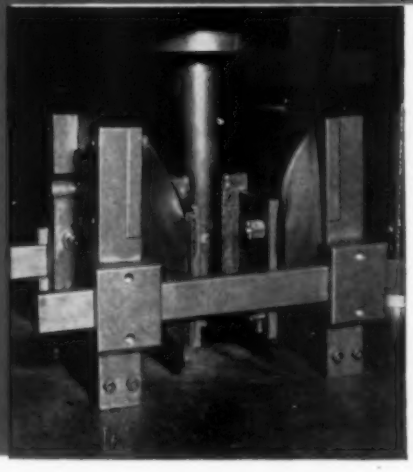


here's another LORD first in development of vibration mountings

In their constant search for improved vibration control, LORD engineers are not content to rely on ordinary testing techniques to prove the physical effectiveness of their designs. That's why they use this Tinius Olsen Testing Machine to put LORD-engineered mountings through exhaustive tests that subject these parts to loads up to many times their rated capacity.

This exceptional machine is comparable to one in the United States Bureau of Standards. It is electro-mechanical with variable speed drive, has a capacity of 200,000 pounds, and uses test speeds from .025 in. per min. to 10 in. per min. It provides for multiplanar tension and compression tests that prove not only the effectiveness of elastomers, but also the strength and life expectancy of bonded products.

The installation and use of this outstanding equipment is typical of LORD development efforts to provide the best in vibration control products—for the future as well as today. When your problem involves vibration control, call upon your LORD Field Engineer or the Home Office for advanced, proved engineering and vibration control products.



Unique test unit, especially designed for Lord, is used for both product development and quality control. High-precision versatility permits compression, tension and transverse loading at capacities to 200,000 pounds.

LORD BONDED RUBBER

designers and producers of bonded rubber products since 1924

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"In Canada—Railway & Power Engineering Corporation Limited"

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new concept in nylon filter

produces low cost, high efficiency filtration

Complete is the word for the modern Danco Nylon filters. Corrosive-resistant Nylon screen is permanently injection molded into the rugged, light-weight Nylon structural frame. The complete unit costs less . . . saves assembly time . . . and delivers maximum filtration with greatest flow.

Almost limitless variations in size, shape and type permit designing and engineering a Danco Nylon filter *exactly* to your requirements. For all the facts, fill out the coupon below.

Danco Nylon filters for engines . . . aircraft . . . machinery . . . coolant and lube systems . . . process industries . . . and a hundred other applications requiring low-cost, high-efficiency filtration.

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Gentlemen: Please send me more information on Danco Nylon Filters.

☐ New Descriptive Specification Sheet
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on ..... Liquid or Gas: .....
(Specific application) (Type)

NAME .....
POSITION .....
COMPANY .....
ADDRESS .....
(Street & Number)
.....
(City) (Zone) (State)

v d-c. No-load output is 5 to 10 rpm at 24 to 30 v d-c, minimum stall torque 30 in-oz. Operating temperature range is −65 F to 160 F and overall length 3.89 in. plus shaft. John Oster Mfg. Co., Avionic Div., Racine, Wis.

For more information—
Circle 69, inside back cover

Wiring Clip

Developed for the attachment of electrical wiring on household appliances, electronic equipment and other products, the clip is front-mounting and is said to eliminate nuts, bolts or auxiliary fastening devices. The clip's spring steel toe is inserted into a mounting hole in a panel and with slight finger pressure down and forward, it snaps into wire-receiving position. Electrical wires can be removed wthout detaching the clip. Tinnerman Products, Inc., Cleveland, Ohio.

For more information—
Circle 70, inside back cover

Indicating Self-Regulated Temperature Control

A front-mounted dial thermometer provides continuous temperature readings of the process under control. The regulator itself automatically governs temperature. Regulator ranges are available to permit control as low as 60 F and as high as 260 F. The dial thermometer is available in calibrations to match. Powers Regulator Co., 3434 Oakton St., Skokie, Ill.

For more information—
Circle 71, inside back cover

Cluster Arm Miniature Switches

A miniature switch with a multi-finger silver alloy cluster arm attached to the rotor may be obtained with from 2 to 12, or 2 to 16 fingers for progressively shorting applications and with 23 or 31 fingers for circuit opening applications. The cluster arm switch assemblies may be ganged with

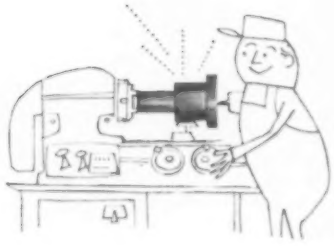
(Continued on page 285)

Saving all you can on

Production Bronze Castings?

Here?

Here?

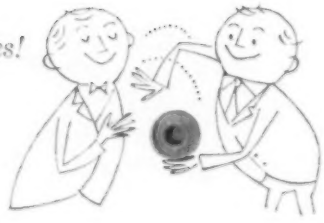


You do, with

Ampco Shell Moldings!

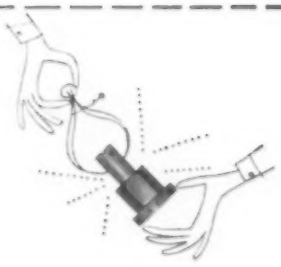
Smoother cast surfaces!

Often, smooth enough to use as is.



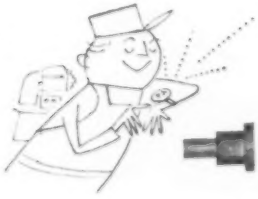
Closer tolerances!

Most castings held to ±.015 — favorable shapes, ±.010.



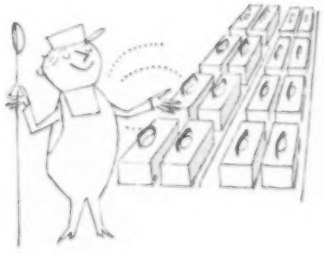
Less machining!

In some cases, finishing operations are eliminated.



Lower cost!

High-speed, semi-automatic mold production means foundry economy.



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Dept. PE-6, Milwaukee 46, Wisconsin

Send me Bulletin G-36 on shell moldings; also information on other Ampco products I have checked.

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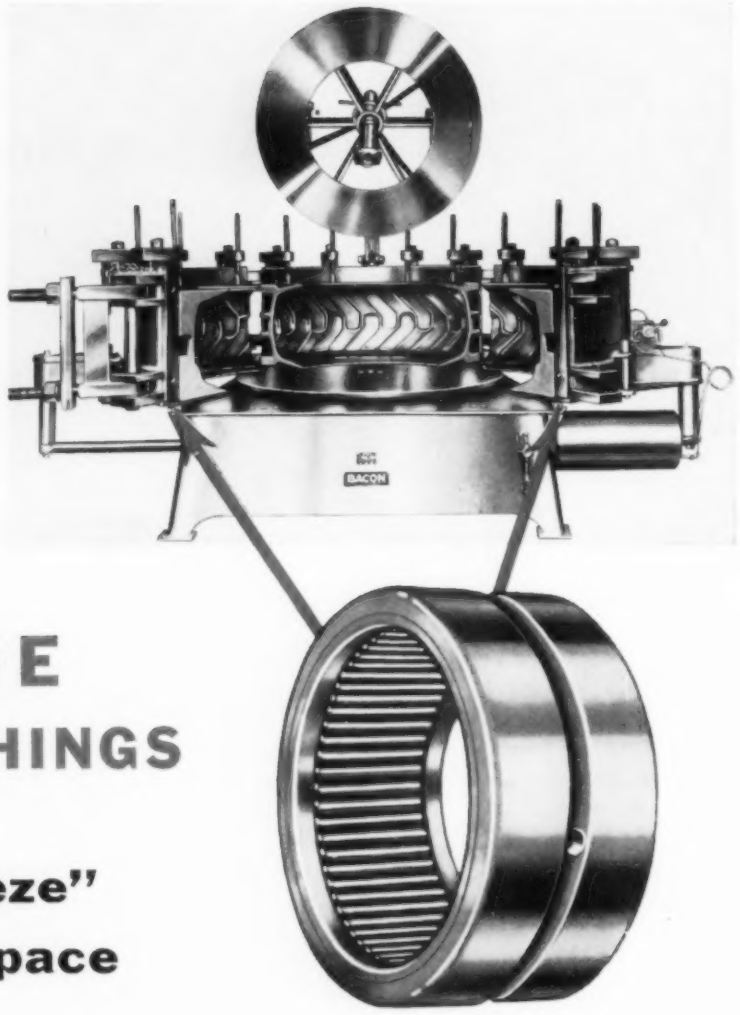
- ☐ Specifications of Ampco Metal
- ☐ Ampco Wrought Products
- ☐ Ampco Stock Raw Materials
- ☐ Ampco in the Process Industry
- ☐ Ampco Centrifugal Pumps
- ☐ Ampco-Weld Resistance Welding Electrodes

D-61

Bacon All-Purpose Tire Molds feature an exclusive "squeeze" principle through air-actuated mechanisms, which provide perfect treads without distortion on all sizes of tires from motorcycle to largest 18:00-24 truck tires. All hinges are mounted on Orange Roller Bushings to eliminate friction and assure smooth operation while opening and closing.



ORANGE ROLLER BUSHINGS meet a "Tight Squeeze" in Load and Space

Orange Roller Bushings are available in stock sizes from ½" to 8" shaft dia., fully interchangeable with all standard heavy-duty needle bearings. Stocks and engineering service in all principal industrial areas.

WRITE for free 40-page Engineering Reference Manual M-56 giving details of construction, dimensions, capacities, etc., on complete line of Orange Roller Bearings.

In addition to meeting load requirements, engineers at Bacon Vulcanizer Manufacturing Company put a "tight squeeze" on space requirements due to the high-load, small-space advantages of Orange Roller Bushings.

Orange Roller Bushings are full-type needle bearings built for heavy-duty service. Rollers and races are made of finest bearing steel—hardened, ground and finished to highest precision standards. Roller uniformity is controlled by electronic gauging, permits closer internal running clearances, minimizes possibility of misaligned rollers.

Wherever a shaft or part rotates or oscillates, Orange Roller Bushings offer great opportunity to fight friction and wear, save space, eliminate trouble spots and improve performance.

ORANGE ROLLER BEARINGS

ORANGE ROLLER BEARING CO., Inc.
551 Main Street, Orange, N. J.

Needle Bearings — Staggered Roller Bearings
Journal Roller Bearings — Thrust Roller Bearings
Cam Followers

Drafting Department Heads!

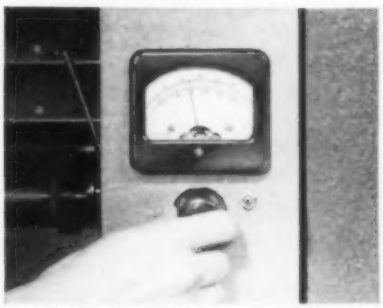
Your older reproduction equipment may be costing you valuable time and man hours!

Get All These Modern Reproduction Advantages with Copyflex!

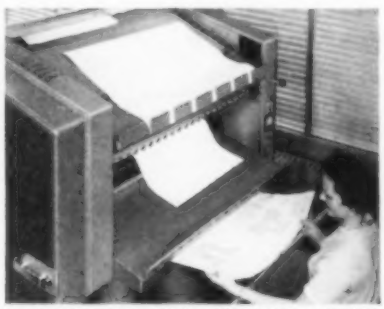
Right now, with production boom demands growing, is the time to take a good look at your reproduction equipment. If it's more than a few years old, chances are it's costing you unnecessary time, man hours, and money.

Compare the performance and features of your equipment with the advantages of modern Copyflex, typified by the Model 500 shown above. You should be getting the time and manpower savings offered by its greater mechanical speed, faster return of originals, automatic separation, front or rear delivery—all these plus the problem-free installation and operation of Copyflex. Seven other great models offer comparable advantages.

If you're not getting these important benefits, then every day you delay getting Copyflex is costing you time and money. Act now by mailing the coupon. You'll be glad you did!



Faster Mechanical Speeds! New Copyflex models introduced within the past two years offer sharply increased speeds—up to 30% faster than before. Synchronized exposure and development assure top quality prints, one knob control simplifies operation.



Greater Convenience of Operation! Modern Copyflex gives printing widths up to 46" to simplify feeding of large tracings, facilitate multiple feedings. Such features as extra-large delivery trays, automatic separation, front-or-rear delivery further speed operator's work.

Problem-Free Installation and Operation! Clean, quiet, odorless . . . Copyflex requires no vents or plumbing. Precision-engineered design, including use of selenium rectifiers instead of troublesome vacuum tubes, assures trouble-free operation.

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Best Process!
Best Machines!
Best Selection of Materials!

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In Canada: Charles Bruning Co. (Canada) Ltd. 105 Church St., Toronto 1, Ontario

Charles Bruning Co., Dept. 63-O
4700 Montrose Ave., Chicago 41, Ill.

Please send me information on the Copyflex process and machines.

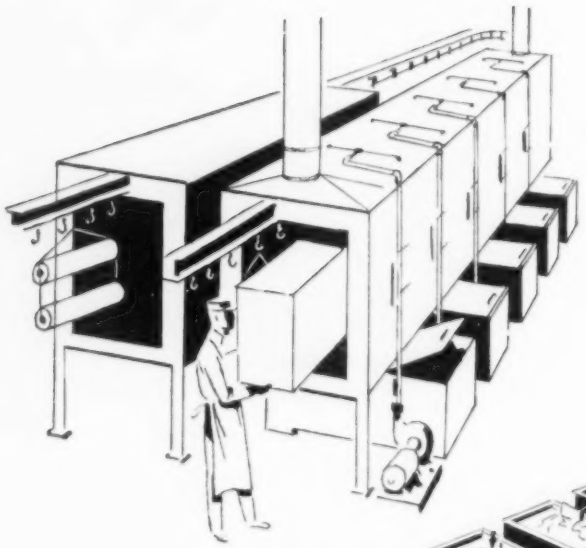
Name _____ **Title** _____

Company _____

Address _____

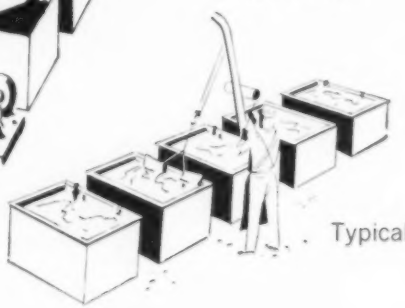
City _____ **County** _____ **State** _____

Treat Metals Fast and Economically with ACP *Chemicals and Processes*



Typical power spray system.

ACP produces the chemicals for treating most metals—to clean them, to prepare them for further processing, to improve corrosion resistance and paint adhesion. It has the experience and the personnel to apply these chemicals economically and effectively, too. Here are just a few of the many products and processes ACP offers:



Typical immersion system.

ACP GRANODINE®—a phosphate coating process for steel which provides an excellent bond for paint and greatly improves the corrosion resistance of the paint system.

ACP ALODINE®—an amorphous coating process for aluminum which protects both painted and unpainted metal and anchors the paint finish.

ACP LITHOFORM®—a phosphate or chromate coating process which prevents objectionable chemical reaction between metal and paint, keeps paint on zinc and cadmium surfaces.

ACP DEOXIDINE®—a phosphoric acid metal cleaner which removes rust and organic soils, destroys rusters, prepares steel, aluminum, brass, copper and other metals for painting.

ACP METAL CLEANERS—Ridoline,® alkaline metal cleaner and Ridosol,® solvent-detergent metal cleaner—remove metal preservatives and metal working lubricants from metals in process.

ACP RODINE®—pickling acid inhibitors which reduce acid consumption, save steel. They also minimize pitting, burning and embrittlement and reduce the formation of acid fumes.

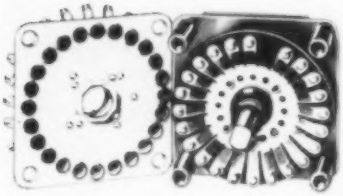
Write for the "ACP GUIDE to the chemical treatment of metals."

CHEMICALS ACP PROCESSES

AMERICAN CHEMICAL PAINT COMPANY, Ambler 17, Pa.

DETROIT, MICH. • ST. JOSEPH, MO. • NILES, CALIF. • WINDSOR, ONT.

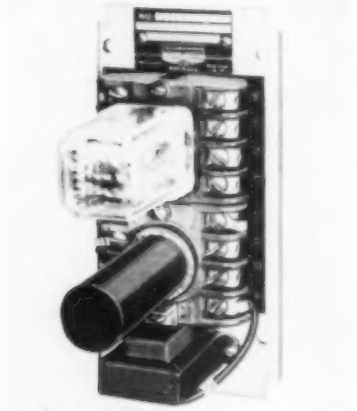
New Chemical Horizons for Industry and Agriculture



conventional decks. They require the same space, and have the same mounting as the regular line of switches.

Applications include ammeter and voltmeter switching, capacitance decades, sequential load substitution and sequential a-c or d-c power substitution. Shallcross Mfg. Co., Collingdale, Pa.

For more information—
Circle 72, inside back cover



Relay With Transistor Amplifier

This component is comprised of a two-pole, double-throw, plug-in relay protected by a polystyrene cover, a plug-in transistor amplifier and power pack module, a 12 v d-c sensing circuit and a low sensing circuit current (less than 0.002 amp.). No warm-up time is required and a terminal board is provided for making external connections.

Low-capacity contact-making devices such as drop wires, feeler switches and gages, contact-making instruments, sensitive thermostats and slow-make, slow-break contacts will operate without electrical damage when used with this relay. Its high-speed operation is reported to make it desirable for use in stop-motion or

(Continued on page 288)

off the shelf service of ACME Precision Chains saves you time and money!

Your Acme Distributor has the chain you need

RIGHT IN STOCK – ON THE SHELF!

Single strand roller chain is always available in 10 and 25 foot lengths at your Acme distributor. Neatly packaged in clean convenient cartons, plainly marked for easier handling and shipping. Packaging eliminates dirt, prevents damage to chain. Available in all standard sizes. Another Acme service you'll find most useful and economical. Reels also available for handling large quantities of Acme Chain. See your Acme distributor.

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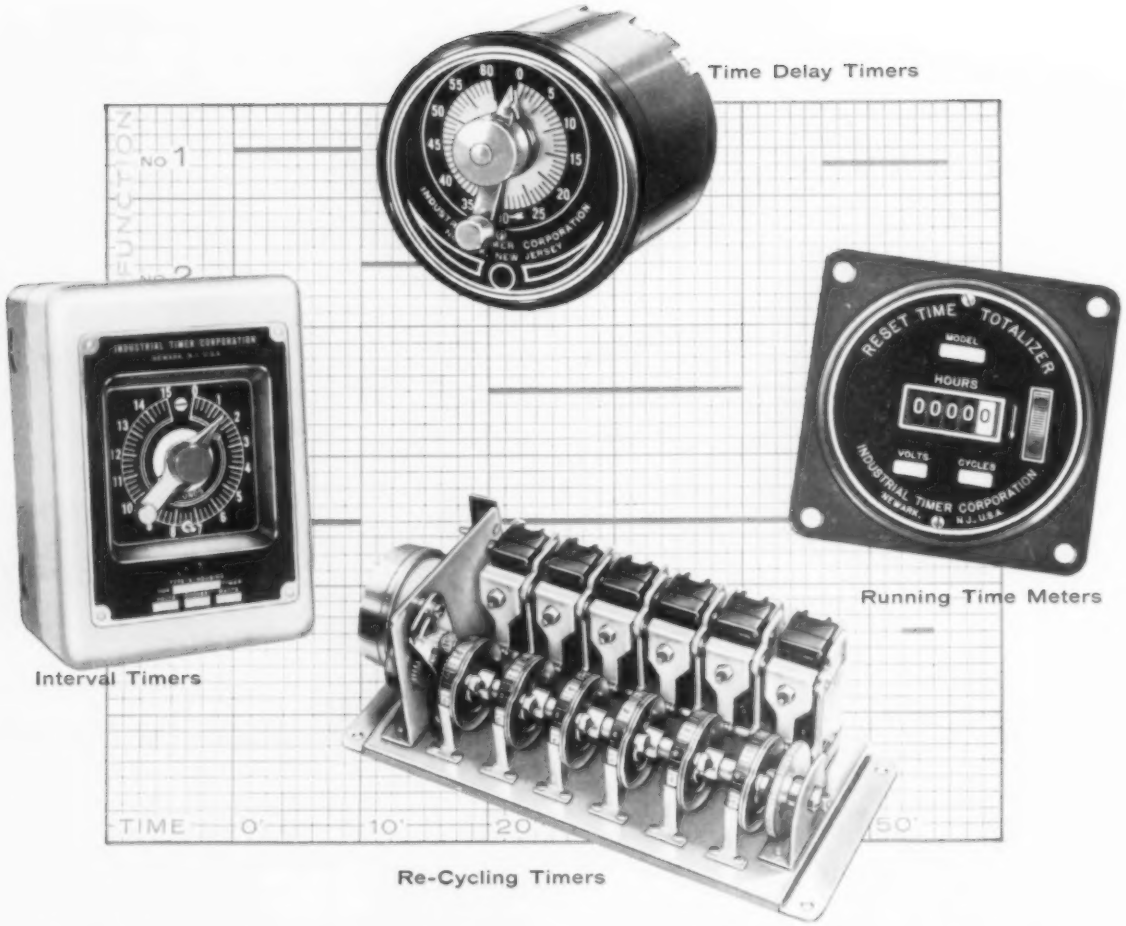
TO THE MEN WHO DESIGN



Timers for Automatic Control ...Standard or Special?

You'll get quick deliveries from Industrial Timer

If slow deliveries of timers have been delaying you in your automatic control projects, try us! True, your problem may be different and difficult indeed, for no two automatic control jobs are exactly alike. But our record in helping out in situations like these is excellent. For in this field we have a valuable background, twenty years of timer experience to be exact, that has provided us with the special knowledge required to supply our customers with the right answers.

How do we do it? The answer is in what we believe to be the largest variety of standard and combination timer units anywhere in the industry. To fill the widely varying needs of our customers, we manufacture a complete line of timers in the four broad classifications illustrated above: Time Delay Timers, Re-Cycling Timers, Interval Timers, and Running Time Meters. From these our timer engineers have developed 20 basic types which they have so far combined in over 1000 different ways. Therefore—many jobs that would seem to require a special timer, are in fact, a standard timer with us.

And our large stock assures you of rapid deliveries—even when we have to create a brand new timer for your special needs. So why not send us your specifications. You'll get a prompt reply and you may save yourself much lost motion.

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

INDUSTRIAL TIMER CORPORATION
1415 McCARTER HIGHWAY, NEWARK 4, N. J.

TO THE MEN WHO DESIGN AND BUILD BETTER PRODUCTS...

Heres How JOHN CRANE CAN HELP YOU!

CHEMLON PRODUCTS

"John Crane" Chemlon offers the remarkable properties of DuPont Teflon in basic forms and parts of all types for practically all applications. These range from basic forms, such as sheet, rod, tubing and tape, to machined, molded or extruded parts fabricated to specification.

Use "John Crane" Chemlon Products for: handling all difficult acids, corrosives and solvents at temperatures from −120°F. to +500°F. . . . electronic insulation where high dielectric strength, high arc resistance and low power factor are vital . . . non-stick applications.

MECHANICAL PACKINGS

"John Crane" maintains nationwide service and engineering to supply mechanical packings for every industrial requirement. Packings are available in all sizes, styles and materials to suit individual requirements and conditions.

Use "John Crane" Packings for: handling all types of liquids and vapors from water and steam to the most destructive acids, alkalis and solvents . . . temperatures to 1200°F. and over . . . to meet your pressure requirements.

MECHANICAL SEALS

"John Crane" engineers seals of all types and sizes for every application. Construction features include positive drive, self-alignment to compensate for normal shaft run out and precision lapped sealing faces.

Use "John Crane" Seals for: all types of rotating shaft applications such as water, steam, boiler feed water, petroleum products and hot oil, acids, corrosives and solvents . . . over a wide temperature and pressure range.

LAPMASTER Lapping Machines

Here's a machine capable of generating surface flatness to less than one light band—finishes to 2 RMS consistantly in short or high production runs . . . a machine that has given many designers an opportunity to obtain product improvement and performance at lower cost.

Use the "John Crane" Lapmaster for: precision lapping of parts for adding machines, engines, transmissions, cameras and projectors, tool and die equipment, quartz crystals, etc. . . . materials such as monel, steel, stellite, brass, aluminum, glass, carbon, plastics and ceramics.

PLASTIC LEAD SEAL* AND THRED-GARD

"John Crane"* PLS easy-to-apply plastic sealing compound provides positive protection against leakers under service applications up to 550°F., 6000 psi. It lasts for the life of the connection, yet permits easy disassembly at any time because it never hardens.

Use "John Crane" PLS for: handling water, steam, gas, petroleum products, chemicals and refrigerants...on pipe joints, threaded connections, plugs, screwed fittings, flanges and gaskets.

"John Crane" Thred-Gard high temperature compound lubricates and prevents seizing and galling of threaded surfaces and fittings under extreme heat conditions up to 1200°F. It permits connections to be drawn to a greater degree of tightness without undue strain.

Use "John Crane" Thred-Gard for: preventing damage to studs on exhaust manifolds, cylinder heads, heat exchangers, coolers, condensers . . . flange bolts on pumps, valves, autoclaves, reactors, kettles . . . die casting dies and die casting machine fittings.

GET FULL DETAILS on how John Crane can help you. Check the information you want, fill out and mail in this coupon.

- ☐ John Crane Teflon Products
- ☐ John Crane Mechanical Packings
- ☐ John Crane Mechanical Seals
- ☐ Lapmaster Lapping Machines
- ☐ John Crane PLS
- ☐ John Crane Thred-Gard

Name _____

Title _____

Company _____

Address _____

_____

Crane Packing Company, 6445 Oakton St., Morton Grove, Ill., (Chicago Suburb). *In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*

JOHN CRANE **CRANE PACKING COMPANY** 38 YEARS INDUSTRIAL PROGRESS

OFFICES IN PRINCIPAL CITIES

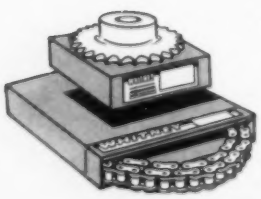
WHERE TWO HEADS ARE BETTER THAN ONE FOR COST CUTTING DESIGNS

Carefully considered drive designs call for Whitney . . . for both specialist engineering assistance, and a complete line of precision steel chains and sprockets. Whitney offers you 60 years of accumulated know-how in solving power transfer and conveying drive problems for a majority of America's industrial production.

Today, for example, keeping pace with modern design requirements in such fields as mining and agriculture, Whitney has developed an exclusive Mine Loader Chain and Self-Lube Agricultural Chain, both bringing new concepts of performance and long life.

Whitney Roller, Silent and Conveyor Chain is available in all A.S.A. sizes. Attachments for Roller and Conveyor Chain increase adaptability and design possibilities. Whitney Sprockets are furnished in all standard types . . . from stock or made to order. Whitney Flexible Couplings are designed for wide adaptability, easy assembly, positive operation and long life.

Whitney Service Centers and distributors assure fast deliveries and engineering assistance throughout the U.S. Write for technical catalogs providing complete data on drive applications.



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CHAIN COMPANY
CREATORS OF SELF-LUBE ROLLER CHAIN
204 HAMILTON STREET • HARTFORD 2, CONN.

ROLLER CHAIN • SILENT CHAIN • CONVEYOR CHAIN • SPROCKETS • FLEXIBLE COUPLINGS

sorting circuits. The low-voltage, noninductive circuit results in no visible arc and thus eliminates dire hazards on applications where the sensing contacts must be near flammable material.

Rated up to 10 amp, 110 v, 60 cps, the relay is available in an open-type panel or NEMA type 1 general purpose enclosure. Cutler-Hammer, Inc., 296 N. 12 St., Milwaukee, Wis.

For more information—
Circle 73, inside back cover

Instrument Overload Protector

For use with D'Arsonval type meter movements, the protector is installed by attaching to the terminals of current meters, and on voltmeters by installing in shunt with the meter movement. Electronic Specialty Co., 5121 San Fernando Road, Los Angeles 39, Calif.

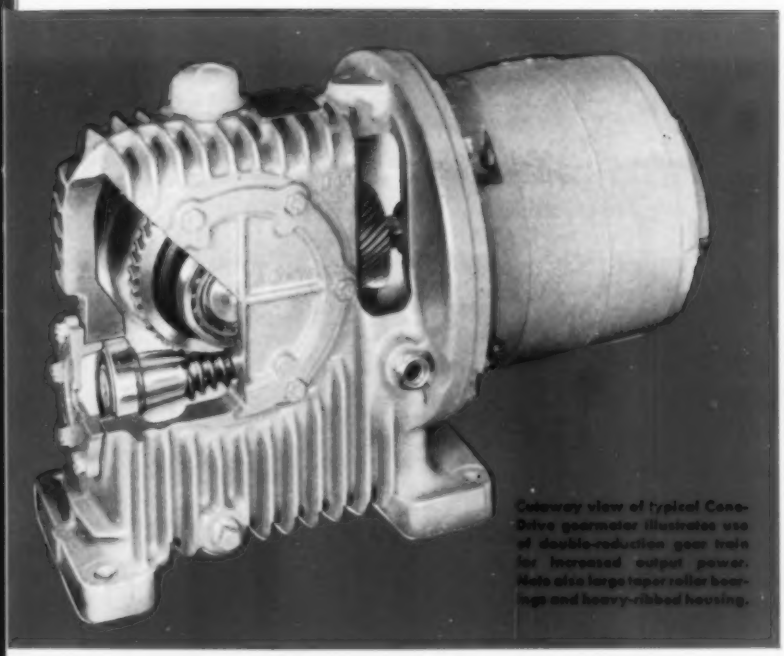
For more information—
Circle 74, inside back cover

Process Controller

A process controller which is said to provide easy change from standard to special temperature ranges, or conversion to control functions such as pressure, displacement or acceleration consist of a control dial and balanced-bridge type circuitry. The circuitry is a modular unit mounted on the front panel. This can be removed and replaced with another unit of different characteristics.

By selecting the appropriate sensor and a matching balanced-bridge unit various ranges of sensitivity and the control of various phenomena is possible. The controller can be used with temperature, pressure, acceleration and displacement transducers.

(Continued on page 293)



Cutaway view of typical Cone-Drive gearmotor illustrates use of double-reduction gear train for increased output power. Note also large taper roller bearings and heavy-ribbed housing.

Announcing a

POWERFUL NEW DRIVE

by

CONE-DRIVE GEARS

Here are the "why's" for this new gearmotor

Why a right-angle gearmotor?
You save space! By tucking the entire unit in close to the driven shaft, there's nothing to stick out in crowded aisles. It's out of the way.

Why a double-reduction design?
More power! Combining a helical primary with a Cone-Drive double-enveloping worm gear secondary gives you an extremely high load-carrying capacity. Output torque ratings are much higher than those of single reduction gearmotors. Overall ratios are greater, too.

Why double-enveloping worm gears?
More power! Cone-Drive double-enveloping worm gears have proven that they provide maximum load carrying capacity on extremely small center distances. This means, in many cases, that they will handle two to four times the load of cylindrical worm gears of the same size. An added plus is high resistance to shock loads, long operating life and minimum maintenance requirements.

Why different types of mountings?
Flexibility! You can select Cone-Drive gearmotors with extended shaft or for shaft mounting. Both are standard. Shaft mounting often permits "hanging" the driven load on the gearmotor to eliminate pillow blocks, bearings, torque arms, shafts, pulleys, bed plates, etc. Both types may be floor, wall or ceiling mounted as desired.

Why 27 standard output speeds?
Standardization! Standard reductions range from 3.3:1 to 240:1. Speeds at 1750 rpm input range from 525 rpm to 7.3 rpm output speed. Any variation in input speed will naturally provide another complete set of 27 output speeds. Any standard type NEMA D-flange motor may be used. Other reductions may be obtained on special order at additional cost.

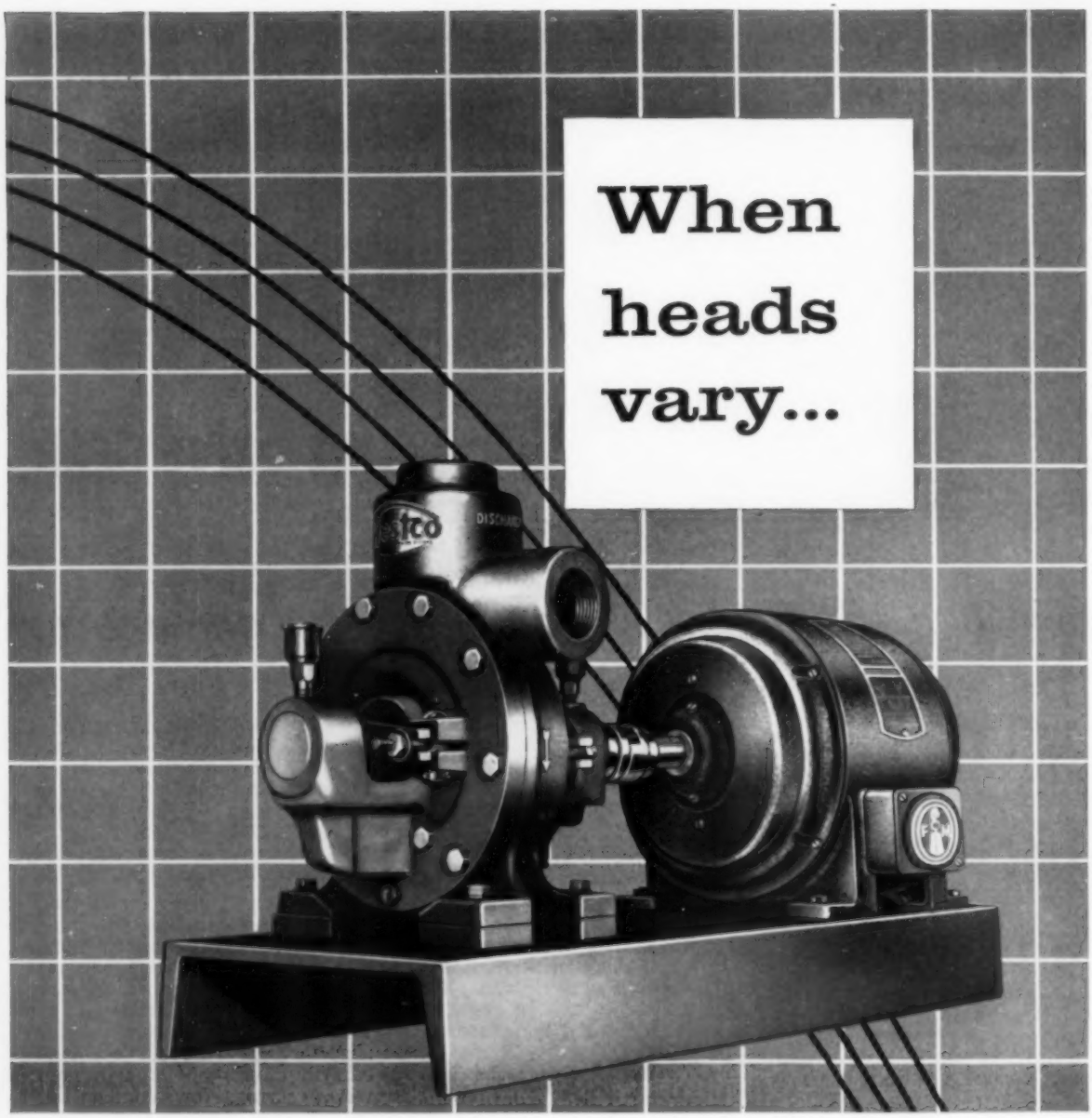
Why ratings to only 25 horsepower?
Demand! Extensive market research by Cone-Drive Gears reveals that this is the most popular power range in the application of gearmotors by industry. Currently we are building models in capacities from 1 to 25 horsepower. However the compact size and high capacity of the Cone-Drive gearmotor will extend this range in the future. Space requirements for higher capacities will be substantially reduced with our new design.

Why a Cone-Drive gearmotor?
Dependability! For over 20 years Cone-Drive Gears has been building double-enveloping worm gears and speed reducers. Design and manufacturing techniques have been constantly improved so that today these unique gears provide, size for size, the highest load-carrying capacity of any right angle worm gearing. Now, you can take advantage of this outstanding gearing combined into an integral package that eliminates pulleys, sheaves, belts, chain, bearings and all the trouble that goes with separate reducer and motor combinations. You'll get increased efficiency at lower cost by specifying standard Cone-Drive gearmotors.

Bulletin #57 contains complete details. Ask for it today.

◀ Here's the finest shaft mounted gearmotor on the market today. It is available in all sizes with ratings identical to other Cone-Drive gearmotors.

CONE-DRIVE GEARS
Division Michigan Tool Company
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNICHOLS ROAD • DETROIT 12, MICHIGAN



Install a Fairbanks-Morse Westco peripheral pump . . . and make sure of efficiency with little or no loss of capacity!

How? Through original F-M Westco design—these pumps deliver approximately the same capacity when discharging against high pressure or low pressure—and all at 1750 rpm.! Another important point: by featuring a multi-vaned impeller, these Westco peripheral pumps deliver multi-stage performance from a single-stage pump.

You'll find Westco peripheral pumps ideal as integral parts of machines, units or systems . . . such as circulating hot water, ice water or brine . . . or for service on clear water, sump, solvents or chemical fluids, feeding filters or boilers, or as booster pumps. Capacities to 200 gpm., heads to 600 feet. For complete information and assistance contact your F-M Pump Dealer, or write today to Fairbanks, Morse & Co., Dept. PE-6, 600 South Michigan Avenue, Chicago 5, Illinois.

FAIRBANKS-MORSE

a name worth remembering when you want the BEST

PUMPS • SCALES • DIESEL LOCOMOTIVES AND ENGINES • ELECTRICAL MACHINERY • RAIL CARS • HOME WATER SERVICE EQUIPMENT • MOWERS • MAGNETOS

OVER-DESIGNING?

If you are designing bronze parts for mass production, there is a good chance that you are specifying a more costly alloy than you need.

ASARCO's patented continuous-casting process produces alloys according to SAE, ASTM and Government specifications. But their performance is entirely unlike that of similar alloys cast in sand or permanent molds. Relatively low-cost alloys cast by the ASARCO process perform like more expensive alloys cast by other methods.

For example, compare Continuous-Cast SAE 660 (ASARCON 773) with more expensive sand-cast alloys:

	Typical Yield Strength	Typical Impact Strength	Brinell Hardness
ASARCON 773	27,000 psi	12.5 ft.-lbs.	72
Sand-Cast SAE 62	20,000 psi	8.7 ft.-lbs.	65
Sand-Cast SAE 64	17,000 psi	8.2 ft.-lbs.	62

Unless you've checked to see whether the unique ASARCO bronzes can give you what you need, there's a possibility that you're over-designing. You may even be able to replace aluminum and manganese bronzes with low-cost ASARCON Continuous-Cast bronzes under certain conditions. Over-designing can be expensive in mass production, even if you are spending only a penny or two extra per pound of bronze.

ASARCON 773 (SAE 660) is readily available from stock in a wide range of sizes. An added bonus is the fact that ASARCON 773 is exceptionally free-machining. Rods, tubes, and numerous "extruded" shapes up to 9 inches in diameter are cast to order by ASARCO in more than 20 alloys.

We'll be happy to send you a free booklet describing the process and the product.

Continuous-Cast Products Department

AMERICAN SMELTING AND REFINING COMPANY

Perth Amboy Plant, Barber, New Jersey • Whiting, Indiana

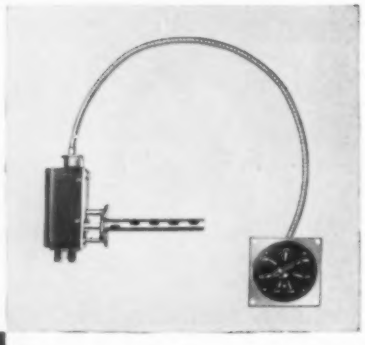
WEST COAST SALES AGENT: Kingwell Bros. Ltd., 457 Minna Street, San Francisco IN CANADA: Federated Metals Canada, Ltd., Toronto and Montreal

S.S.White

Flexible Shafts Withstand Temperature Extremes!

A leading aircraft manufacturer has used S.S. WHITE flexible shafts for many years to transmit control between this graduated dial and aircraft thermostat. He finds that under any kind of temperature conditions, there is no measurable variation in torque to turn the shaft, or in torsional deflection required to initiate cam movement over the temperature range!

This ability to withstand temperature extremes is only one of the many remote control and power drive advantages industry has discovered in S.S. WHITE flexible shafts. Perhaps they can help you to simplify control or product design . . . cut your production costs . . . speed assembly. These quality shafts range from small to large sizes, and up to 12 feet in length. The assistance of our engineering staff in helping you work out a flexible shaft application for your product is yours for the asking. Just write to



S.S.White

FIRST NAME IN FLEXIBLE SHAFTS

USEFUL DATA on how to select and apply flexible shafts. Write for Bulletin 5601.

S. S. White Industrial Division, Dept. D, 10 East 40th St., New York 16, N. Y. Western Office: 1839 West Pico Blvd., Los Angeles 6, Calif.

The basic control mechanism is an electronic switch which is housed in a standardized aluminum case. The controller, as standard equipment, offers temperature control from 0 to 250 F, with control sensitivity of 1 F. Autron Engineering, Inc., 1254 W. 6 St., Los Angeles 17, Calif.

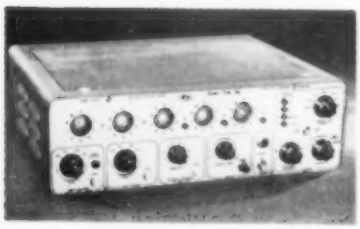
For more information—
Circle 75, inside back cover

Digital Ohmmeters

Both four-and five-digit models are made up of two modules: a universal power module and a resistance switch module. The switch unit contains all three arms of a full Wheatstone bridge, as well as the visual read-out. The universal power unit supplies all power and reference voltages for the resistance switch device and for other modules which might be combined with the resistance switch.

The ohmmeters provide automatic resistance measurements from 10 miliohm to 10 megohms. Electro Instruments, Inc., 3794 Rosecrans, San Diego, Calif.

For more information—
Circle 76, inside back cover



Frequency, Period and Time Interval Meter

This counter has one glow transfer counting tube per decade for both counting and indication, 200 mv input sensitivity, a self-test function switch for checking internal time base and counter decades, measuring capacities from 0.1 to 100 kc and 10 micro-

(Continued on page 296)

Five reasons why Townsend Versa-rivets* give you superior fastening

Townsend Versa-rivets are versatile, self-plugging blind rivets which can be set easily and rapidly by one man from one side of the work. They save assembly time and allow greater flexibility in product design. Here are the five qualities which mean ideal fastening at lower costs:

1. Strong clinch and resulting high resistance to vibration are obtained with Versa-rivets. In setting them, the shank is expanded against the face of the back sheet, drawing the two sheets together and clinching them effectively, as shown above.

2. Versa-rivets provide a positive hole fill because the stem is drawn down to completely fill the hole in the members being assembled. Sound, strong riveted joints are obtained in holes up to .025" oversize with shear values comparable to solid rivets.

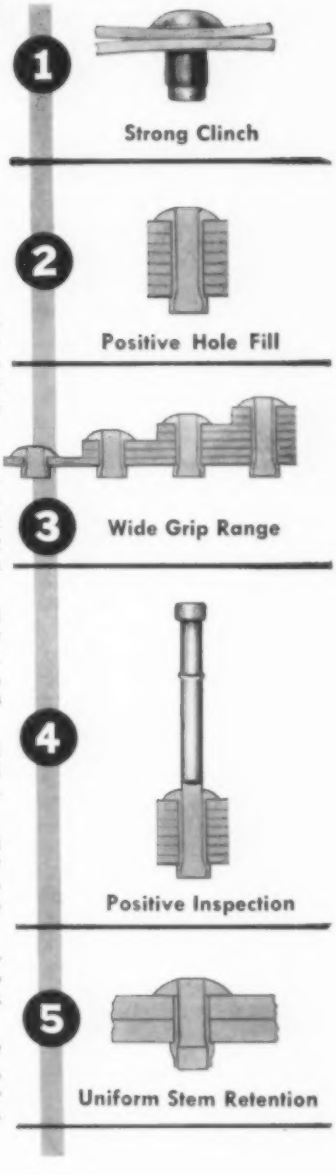
3. Inventory problems are greatly reduced by the wide grip range as demonstrated above. A single length handles various thicknesses.

4. When the Versa-rivet is set, the enlarged section of the stem protrudes approximately 3/32" above the rivet head, giving visual indication from one side of the work that the rivet is properly set.

5. The Versa-rivet always provides uniform strength as the stem always adjusts to fill the hole. Stem retention is independent of the hole size and is uniformly high.

If you would like complete details on how Versa-rivets can improve your fastening, write for Bulletin TL-119. Townsend Company, P.O. Box 237-D, New Brighton, Pa.

*Patents issued & pending.



The Fastening Authority

Townsend

COMPANY • ESTABLISHED 1816

NEW BRIGHTON, PENNSYLVANIA

Sales Offices in Principal Cities

Cherry Rivet Division • Santa Ana, California

In Canada: *Parmenter & Bulloch Manufacturing Company, Ltd., Gananoque, Ontario*

(ADVERTISEMENT)

Facts to consider when you're buying

Chromate Conversion Coatings

for Corrosion Protection, Paint Base, Decorative Finishing

WHAT IS IRIDITE®?

Briefly, Iridite is the tradename for a specialized line of chromate conversion finishes. They are generally applied by dip, some by brush or spray, at or near room temperature, with automatic equipment or manual finishing facilities. During application, a chemical reaction occurs that produces a thin (.00002″ max.) gel-like, complex chromate film of a nonporous nature on the surface of the metal. This film is an integral part of the metal itself, thus cannot flake, chip or peel. No special equipment, exhaust systems or specially trained personnel are required.

If your company is manufacturing or buying parts or complete assemblies made from or plated with any of the more common non-ferrous metals—zinc, cadmium, aluminum, magnesium, silver, copper, brass or bronze—you've probably already run up against the question of finishing these surfaces with a chromate conversion coating. These coatings are used to protect against corrosion, or to provide a base for paint or to provide a decorative finish for sales appeal or shelf life. Since chromate conversion coatings represent a relatively new means of obtaining these finishes, this digest of facts to consider may be of value to you.

1. THE COATINGS THEMSELVES. There are many brands on the market. All are similar in many ways. Each, of course, offers its own specific advantages and these may relate to operating techniques, performance under actual use conditions, cost, availability, etc. Naturally, you'll want to choose a coating that is widely known and accepted under both military and civilian specifications.

2. THE COMPANY BEHIND THE PRODUCT. Is it a reliable, established organization? Does it offer experienced technical service, both from the field-engineering organization as well as the home office and laboratories? The man who sells and services your installation should be thoroughly familiar with not only chromate conversion coatings and their applications, but also with the characteristics and performance of related finishing operations such as precleaning, electroplating, painting, etc. This is most important since all steps of the finishing cycle must be functioning properly for the satisfactory performance of the ultimate finish produced.

3. AVAILABILITY OF THE PRODUCT. Ideally, of course, the material should be readily available to you from nearby warehouses to avoid time loss in long distance shipping and to provide emergency service, should the need arise.

4. COST. Naturally, the initial price of the material is important to you. However, just as you consider ultimate cost when you are buying mechanical equipment, ultimate cost must be considered for these finishing chemicals. So, it will pay you to investigate consumption costs, labor costs and the other factors which go into the determination of ultimate cost. Further, cost alone gives no indication of product performance, so careful attention must be given to the purpose the finish must serve and the value that finish will add to your product.

5. FACILITIES FOR RESEARCH AND DEVELOPMENT. Perhaps the existing types of chromate conversion coatings do not include a compound that will accomplish exactly what you wish. Then, it is important to deal with a supplier who has adequate research and development facilities available to work with you to produce a material to meet your needs. Naturally, such a project is seldom completed overnight. But, with complete cooperation and confidence from both you and your supplier, chances are a satisfactory program can be completed.

These are the concepts of sales and service on which we, Allied Research Products, Incorporated, have developed and marketed the line of Iridite chromate conversion coatings . . . superior product performance, complete sales and technical service, easy product availability, economical cost, extensive research and development facilities. No doubt you are familiar with our line and have seen this trademark—

IRIDITE®

—in our advertising, technical literature or on shipping containers in your plant. Remember this trademark when you're buying or investigating chromate conversion coatings for your company. It's your assurance of quality, economical products from a reliable and established company, skilled sales and technical service from both our home office and a national network of representatives, immediate availability from warehouses in strategic industrial areas and our willingness to work with you to develop new finishes to meet your needs, should the present line fall short.

For complete information on Iridite chromate conversion coatings, write today for your free copy of our technical data file. Or, for immediate advice, call in your Allied Field Engineer. He's listed under "Plating Supplies" in your classified telephone book.

ALLIED RESEARCH PRODUCTS
INCORPORATED
4004-06 E. MONUMENT STREET • BALTIMORE 5, MD.

Manufacturers of Iridite chromate conversion coatings for corrosion resistance, paint systems, final finishing of non-ferrous metals; ARP Plating Brightener & Chemicals. West Coast Licensee—L. H. Butcher Co.

TECHNIQUES and DEVELOPMENTS in oscillographic recording

FROM SANBORN

RECORDING METHOD USED IN SANBORN DIRECT WRITERS, AND A REVIEW OF THEORETICAL AND ACTUAL ERROR FACTORS

Figure 1 shows the basic scheme by which Sanborn oscillographic recording galvanometers produce graphic records of electrical signal values. If the rapid deflection action of the heated ribbon tip stylus is visualized when current flows in the coil, it can be seen that a straight line at right angles to the chart length is recorded on the chart, at the point where the chart is drawn over a knife edge. The trace, therefore, is a true rectangular co-ordinate graph.

Since this is essentially a process of expressing coil (or stylus) deflection *angles* in terms of *distances* on a chart, the trigonometry of the situation (Fig. 2) must be examined to ascertain the accuracy of the method. Initially, and when θ is small, the tangent and the angle are almost equal numerically. The expression $D = R \tan \theta$ can, therefore, be rewritten $D = R\theta$ (approx.). To the extent this latter expression is true, deflection distances (rather than deflection angles) are an accurate measure of signal values. But to determine the extent of error resulting from using this approximation, the following data have been calculated*, using a chart width of 25 mm either side of zero ("D" in Fig. 2) and effective stylus length of 100 mm ("R" in Fig. 2) in the series expansion for the tangent function. Error as a function of deflection then becomes:

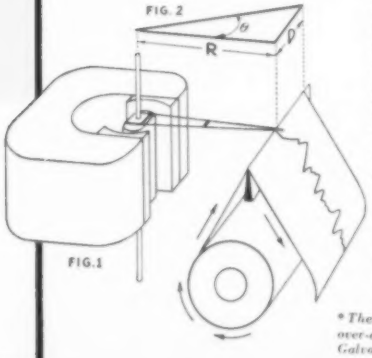


FIG. 1

D mms	Radians	Theoretical Error ε	Corrected Error δ	Corrected Error in mms
10	.10	.0033	0	0
15	.15	.0075	.004	.06
20	.20	.0133	.010	.20
25	.25	.0209	.018	.45

When the recording system is calibrated, that calibration is often made on the basis of a one centimeter deflection from the chart center, or by means of a two centimeter deflection starting one centimeter below chart center and finishing one centimeter above chart center. In either case the deflection at one centimeter from chart center is accepted as the standard, and, therefore, is without error. The foregoing table can therefore be corrected by subtracting .0033 from each of the error terms to show the error, δ, to be expected in actual use. The final column in the table shows this error in mms.

Since the active length of the stylus increases as θ increases, deflection D increases more rapidly than θ. All positive error terms in the series expansion bear this out, but the error terms would occur as predicted only if the galvanometer produced deflections exactly proportional to coil currents (that is, ideal spring properties in the torsion rods and uniformity of magnetic field). Pole tips in Sanborn galvanometers are proportioned so that in maximum deflections, galvanometer sensitivity *decreases* slightly, the compensation resulting in *actual* linearity better than that predicted in the table.

**The mathematics involved here, as well as a discussion of fixed length styli, design parameters affecting over-all galvanometer performance, etc., are contained in an article by Dr. Arthur Miller "Sanborn Recording Galvanometers", published in the May 1956 Sanborn RIGHT ANGLE. Copies are available on request.*

RECOGNIZE A "150" RECORD BY THESE *THREE* FEATURES...

1% Linearity

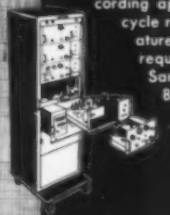
. . . resulting from use of current feedback Driver Amplifier in each channel, high torque galvanometers of new shorted coil frame design. Coil current of 10 ma develops 200,000 dyne cm torque, sensitivity is 10 ma/cm deflection.

Rectangular Coordinates

. . . save analysis time, simplify interpretation and correlation of multichannel records. No waveform curvature, negative time lines, etc.

Permanent Inkless Traces

. . . made by hot nichrome ribbon tip of stylus on heat-sensitive Sanborn Permapaper. Clear, smudge-proof traces that clearly reveal minute signal changes.



Call on Sanborn engineers for help with your oscillographic recording application in the 0-100 cycle range. Descriptive literature is also available on request, providing data on Sanborn 1-, 2-, 4-, 6- and 8-channel Systems, choice of 12 interchangeable plug-in Preamplifiers, Separate and Supplementary Instruments.

SANBORN COMPANY
Industrial Division
175 Wyman Street, Waltham 54, Mass.

Compressor Model 4565-P3 to 20 p.s.i.

Vacuum Pump Model 4565-V6 to 25" hg.

Big NEW 45 c.f.m. fan-cooled Model 4565

GAST rotary vane AIR PUMPS—

Twice the capacity of previous models!

COMPRESSOR

Delivers to 45 c.f.m., to 20 p.s.i.g. continuously with 5 h.p. motor at 1750 r.p.m. At lower pressures, 3 h.p. may be used. Includes automatic lubricator, felt type intake filter.

VACUUM PUMP

Delivers to 45 c.f.m., vacuum to 25 in. hg. with 3 h.p., 1750 r.p.m. For 35 c.f.m. at 1350 r.p.m., 2 to 3 h.p. is adequate. Has heavy-duty lubricator and exhaust muffler.

WRITE TODAY for Bulletin 557-VP with performance data.

Here's new, bigger-volume air pump utility—for original equipment or plant use! Built for continuous, heavy-duty service as either a Compressor or Vacuum Pump, the Model 4565 eliminates water-cooling headaches. It's air-cooled by a 10" diameter pitch fan enclosed by cowl-guard which directs cooling air and insures safety by covering fan mounted on shaft extension.

Long-lived, efficient 5-vane rotary design delivers a positive displacement of pulseless air. No air tank is needed on compressor.

Pump is easy to mount. Drive with double v-belts eliminates precision alignment problems, and fan on pulley adds extra cooling capacity. Heavy ball bearings, with double row on drive end. Pump weight approximately 92 lbs.

Investigate Gast Model 4565—it may solve a problem for you! **Gast Manufacturing Corp.**, P.O. Box 117-V Benton Harbor, Michigan.

SUGGESTED APPLICATIONS

As volume source of low pressure air or vacuum, independent of plant air lines. COMPRESSOR: For air atomizing No. 5 or 6 fuel oil on burners for packaged boilers to 500 h.p., etc. VACUUM PUMP: Does the work of two smaller pumps for paper or sheet feeding to printing presses, packaging, labeling or bottle-filling machinery. Suitable for pipe-line milking machines, and for vacuum-forming large plastic sheets. Recommended for dry vacuum only.

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- AIR MOTORS TO 4 H.P.
- COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.

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sec to 1.2 days, and a counter tube life expectancy of over 10,000 hr.

Dimensions are 5½ x 17 x 14 in. deep. Electro-Pulse, Inc., 11861 Teale St., Culver City, Calif.

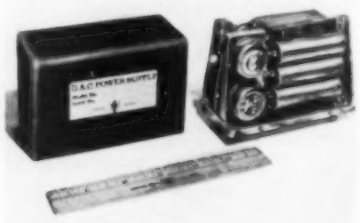
For more information—
Circle 77, inside back cover

Power Supply for Programming

A power supply may be automatically programmed by punched tape or any system which supplies binary-coded decimal signals. It supplies d-c voltages in 1-v steps from −300 v to 300 v, and at currents from 0 to 200 ma. Voltages are selected by applying pulses to a group of relays operating in binary-coded decimal combinations.

The unit uses a 105-125 v a-c, 60 cps input. Regulation for no-load to full load is 50 mv at 1 v, 80 mv at 300 v, with ripple at a 4 mv max. Dressen-Barnes Corp., 250 N. Vinedo Ave., Pasadena, Calif.

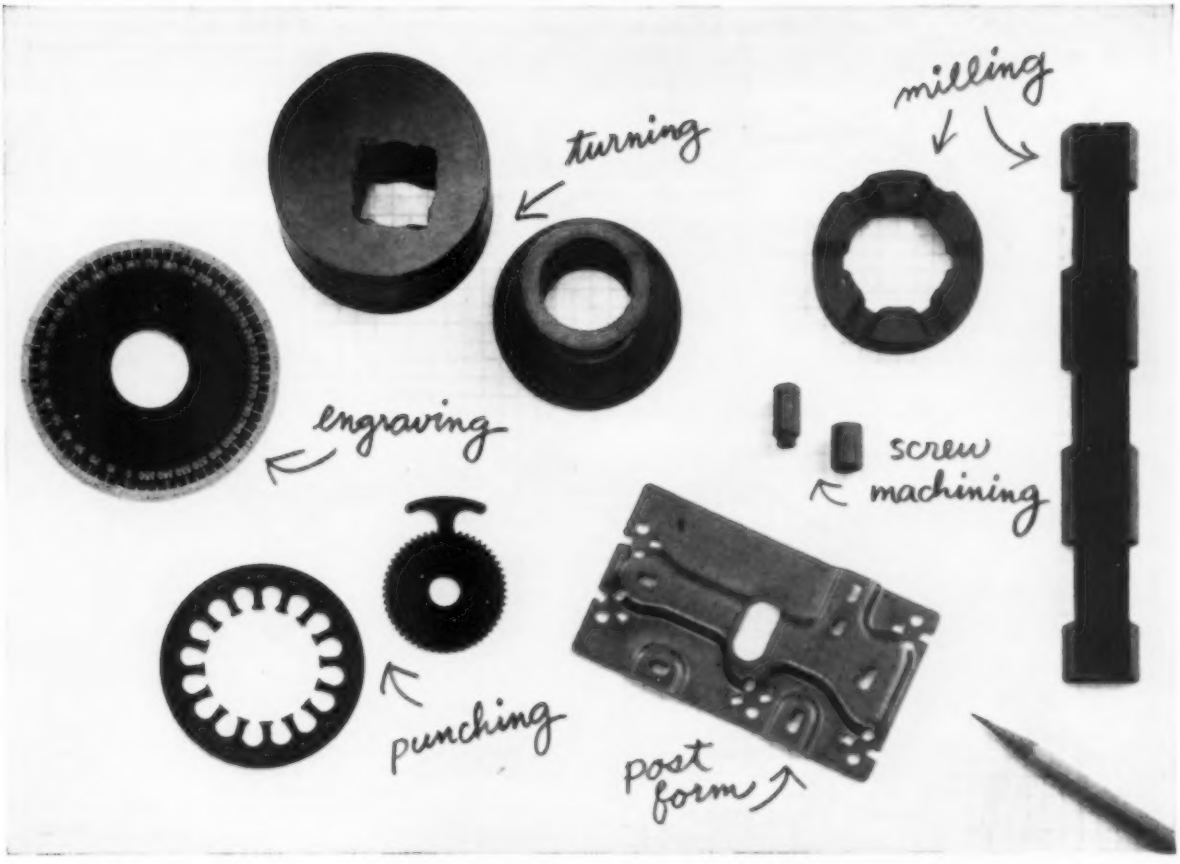
For more information—
Circle 78, inside back cover



D-c to d-c Power Supplies

A series of d-c to d-c power converters for portable, aircraft, and vehicular electronic equipment are available for 12 and 28 v inputs, in a number of nominal output voltages from 120 to 21-0 v, and in power outputs up to 500 w. Input and output voltages and higher power ratings are

(Continued on page 300)



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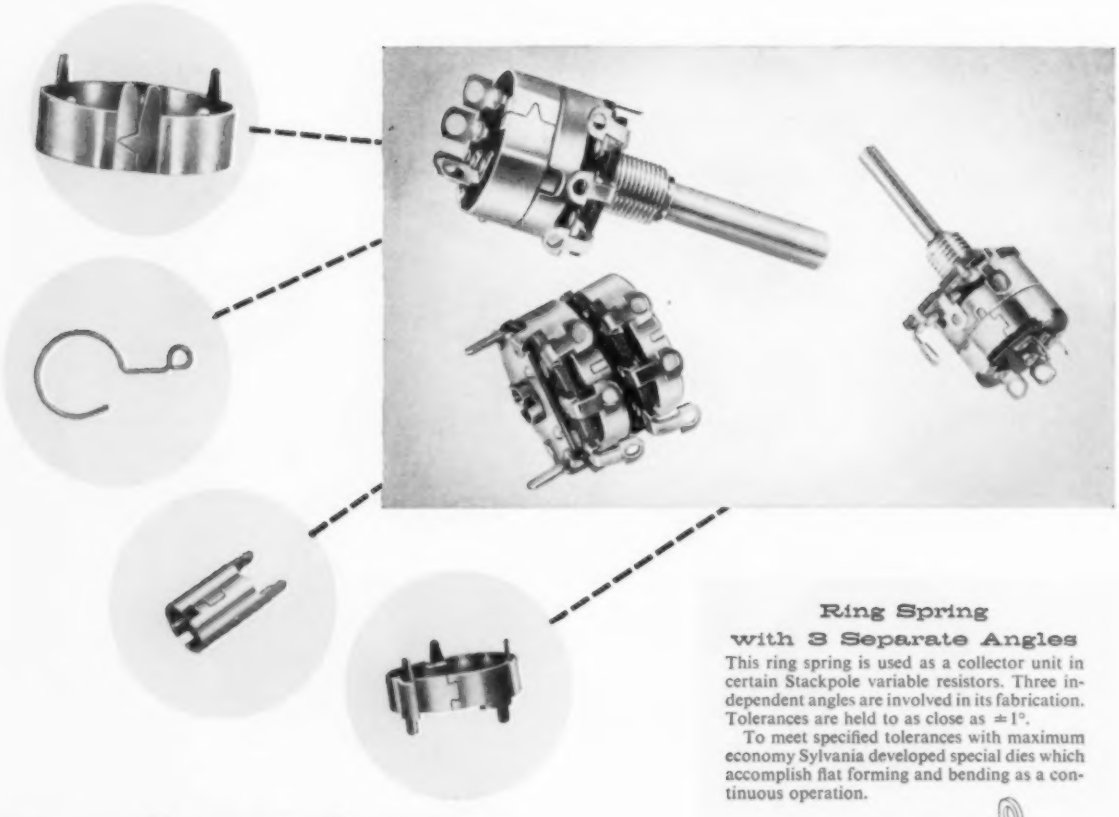


Formed metal parts

from Sylvania help assure inherent quality of STACKPOLE variable resistors

Stackpole designs and manufactures components to meet high standards of quality in electrical-electronic products.

For precision and uniformity in the volume production of critical metal parts used in variable resistors, the Stackpole Carbon Company relies on Sylvania's Parts Division.

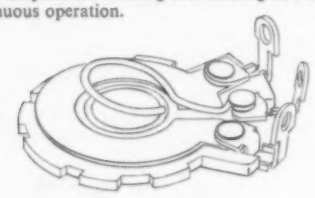
Many leading manufacturers, large and small, use Sylvania's 4-way service for high volume production of close tolerance parts. Let us submit a quotation on your specifications calling for custom-molded plastic parts . . . plated or clad specialty wire . . . electronic components . . . or formed metal parts.

For information on our facilities write for free copy of: "Portfolio of 4-way Service to Designers."

Ring Spring with 3 Separate Angles

This ring spring is used as a collector unit in certain Stackpole variable resistors. Three independent angles are involved in its fabrication. Tolerances are held to as close as ±1°.

To meet specified tolerances with maximum economy Sylvania developed special dies which accomplish flat forming and bending as a continuous operation.



Formed Switch Covers and Shaft

These are typical metal stampings used in certain Stackpole variable resistors. Sylvania's experience and know-how in fabricating small parts result in high volume production at low costs. Hollow shaft is carefully formed to hold diameter within ±.0025". Dovetail on large cover was designed by Sylvania to avoid nestling and tangling of parts during handling.

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Sylvania Electric Products Inc., Parts Division, Warren, Pennsylvania

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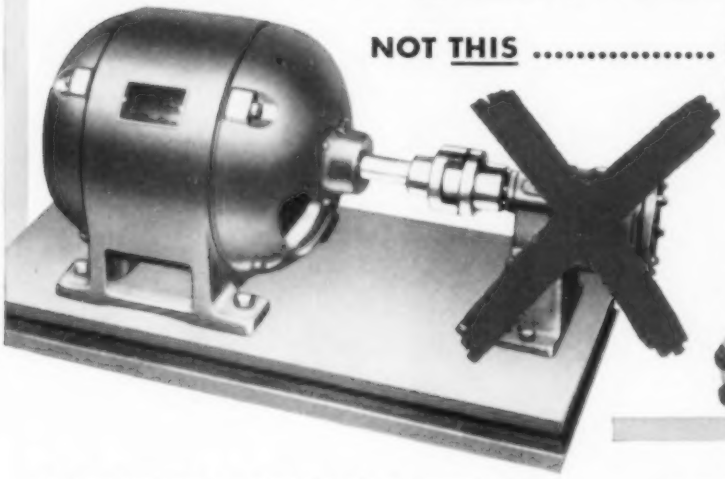
NOW AVAILABLE!

New TUTHILL Positive Displacement Pump-and-Driving-Motor Units Require Less Space ...Have No Couplings, Adapters or Base



NOT THIS ..... BUT THIS TUTHILL PROMPTLY-DELIVERED SPACE-SAVING UNIT

● Now there are *two* means by which the problems of space, weight, time and cost can be solved in the application of hydraulic, oil burning and lubricating pumps and motors to industrial equipment.

First, the use of compact, custom-built TUTHILL "POWERMITE" pump-and-driving-motor units for original equipment manufacturers having QUANTITY requirements.

Second, the use of compact, standard, promptly-available TUTHILL pump and driving motor units *for individual applications which do not warrant custom design.*

PUMP MOUNTED ON THE MOTOR

Both provide—with no coupling, adapter, or base:

1. **Important savings in space.**
2. **Reduced weight for less shipping and handling costs.**
3. **Fewer components, thus less expense.**
4. **Less assembly time.**

A typical standard TUTHILL pump-and-driving-motor unit is shown above. Note that *the pump is mounted on the motor*...eliminating the need for coupling, adapter and base...and time normally required for their assembly. In comparison with a regular assembly, the new driving unit saves a minimum of 6 inches in space and weighs several pounds less. The TUTHILL rotary positive displacement pumps used in these driving units range in flow capacity from 20-300 GPH and in pressures up to 1500 PSI. The combinations include ¼ HP motors and larger.

...WHICH REDUCES COST AND TIME ($$) TOO

FOR THE OCCASIONAL USER

These latest TUTHILL units extend the advantages of our compact, original equipment design to the occasional user of pump-motor units—the industrial firm interested in individual or minimum quantity orders and prompt delivery.

TUTHILL Positive Displacement motor-and-pump units offer a wide variety of combinations for use in hydraulic, oil burning, lubricating and other services involving many different fluids. The model shown has a capacity of 90 GPH and a ¼ HP motor with a speed of 1750 RPM.

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STREET_____

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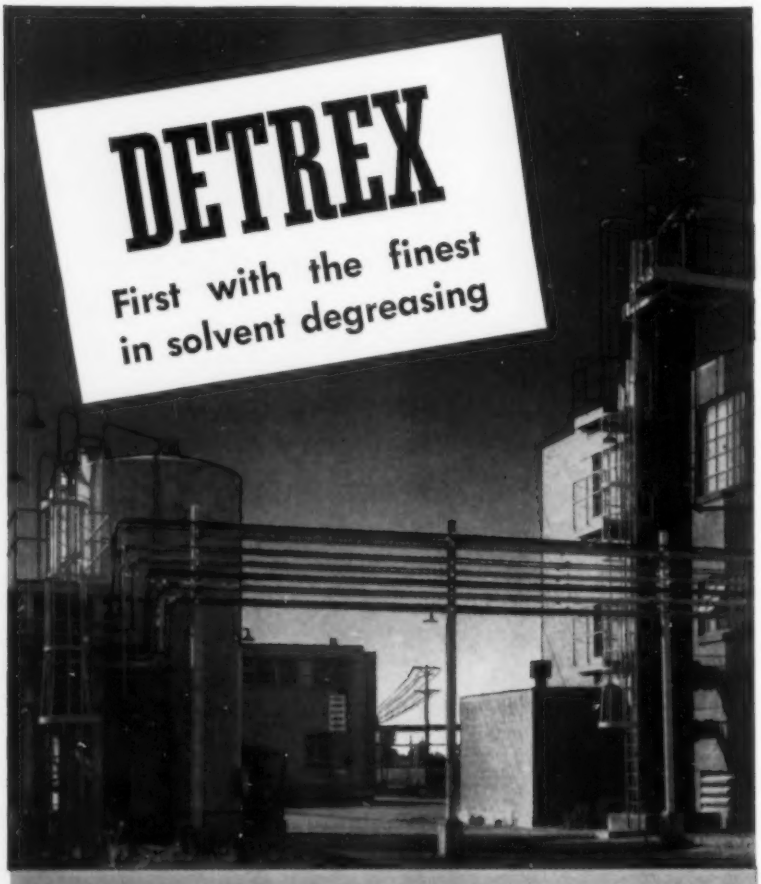

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New DETREX PERM-A-CLOR* trichlorethylene degreasing solvent - stabilized to a new high degree - has been proven on the toughest of metal cleaning jobs.

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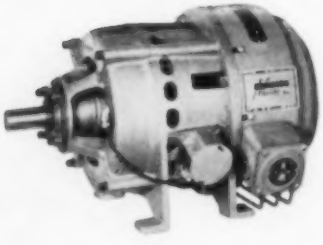
available on special order as high as 12 amp or 100,000 v. UAC Electronics Div., Universal Transistor Products Corp., 143 E. 49th St., New York 17, N. Y.

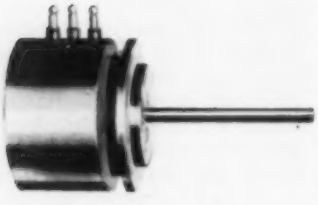
For more information—
Circle 79, inside back cover



Motor-clutch-brake Package

A motor-clutch-brake drive with controls is said to provide fast or slow start with acceleration, deceleration and/or stops in automatic cycles up to 30 per min. Designed around a Fairbanks-Morse axial air-gap motor coupled to magnetic clutch and brake components, the unit is available in 1½ through 15 hp sizes, all with constant torque and at standard motor speeds between 600 and 1800 rpm. Maximum diameter is 18 in., with overall drive length no greater than 30 in. Available as standard unit with d-c rectification incorporated and with special control cabinet for automatic cycling. Ericsson Merritt, Inc., 522 Pine St., Lockport, N. Y.

For more information—
Circle 80, inside back cover



A-c Rotary Transducers

Rotary transducers for sensing angular displacement exhibit linearity of ±0.5% or better through 60° of best linear range, and of +1% over entire 120° linear range. Miniature

(Continued on page 303)

precision ball bearings support shaft, otherwise there are no mechanical contacts between rotor assembly and bridge housing to produce friction or electrical noise. Sensitivity is 1 mv/v/° rotation, reproducibility is said to be better than 0.1% and resolution is limited only by external circuitry. Operates in ambient temperatures from −70 F to 180 F. Crescent Engineering & Research Co., 5440 N. Peck Rd., El Monte, Calif.

For more information—
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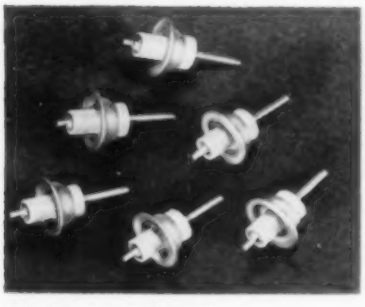


Miniature Alumina Terminals

These terminals are ⅜ in. dia, and have a voltage rating of 3500 v (sea level). The center conductor and insulating sleeve are vacuum-sealed in a metal flange which can be hermetically sealed to the mounting surface with either soft or hard solder. Various finishes available. Applications include ultra-compact airborne units for high-altitude operation. Raytheon Mfg. Co., Waltham 54, Mass.

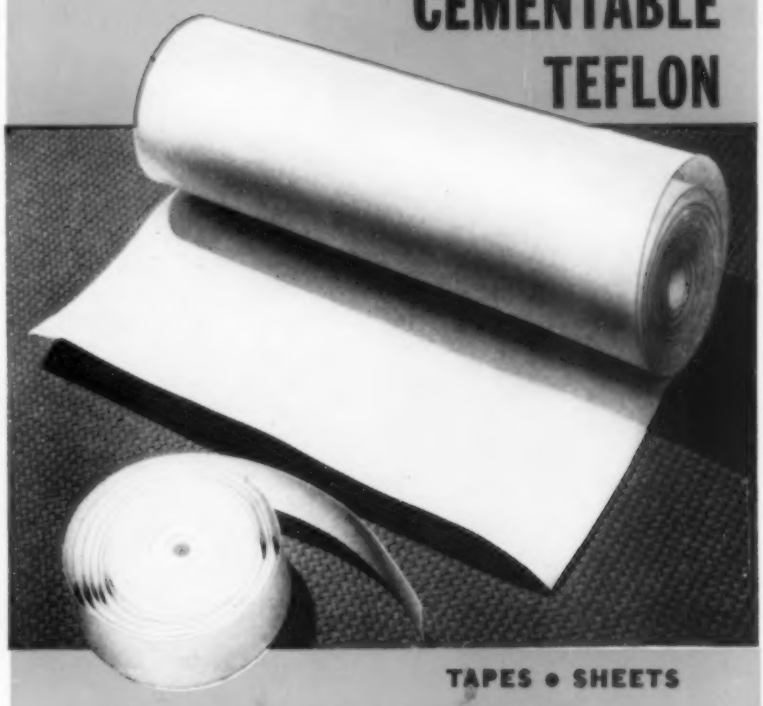
For more information—
Circle 82, inside back cover

Subminiature Solenoids

The average size of the solenoids is ½ x ½ in. long and they operate under severe conditions of shock and vibra-

(Continued on page 306)

now... design with CEMENTABLE TEFLON



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- Provides smooth unblemished surface.
- Requires no mechanical fasteners.
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Dielectric base for printed circuit material; motor windings and coil forms; dielectric shields for electronic chassis and components; hermetic sealing of components, etc.

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Anti-friction linings for hoppers, chutes, powder measuring and feeding devices; conveyor and packaging machine guides; bearing liners; non-adhesive work surfaces, machine linings, roll coverings, confectionery molds; ski and skid facings; frictionless surfaces for electro-mechanical instrument, valve, pump and machine parts, etc.

Cementable TEFLON is offered with surface treatment on one or both sides. Ask your nearest Garlock district office or write for literature—

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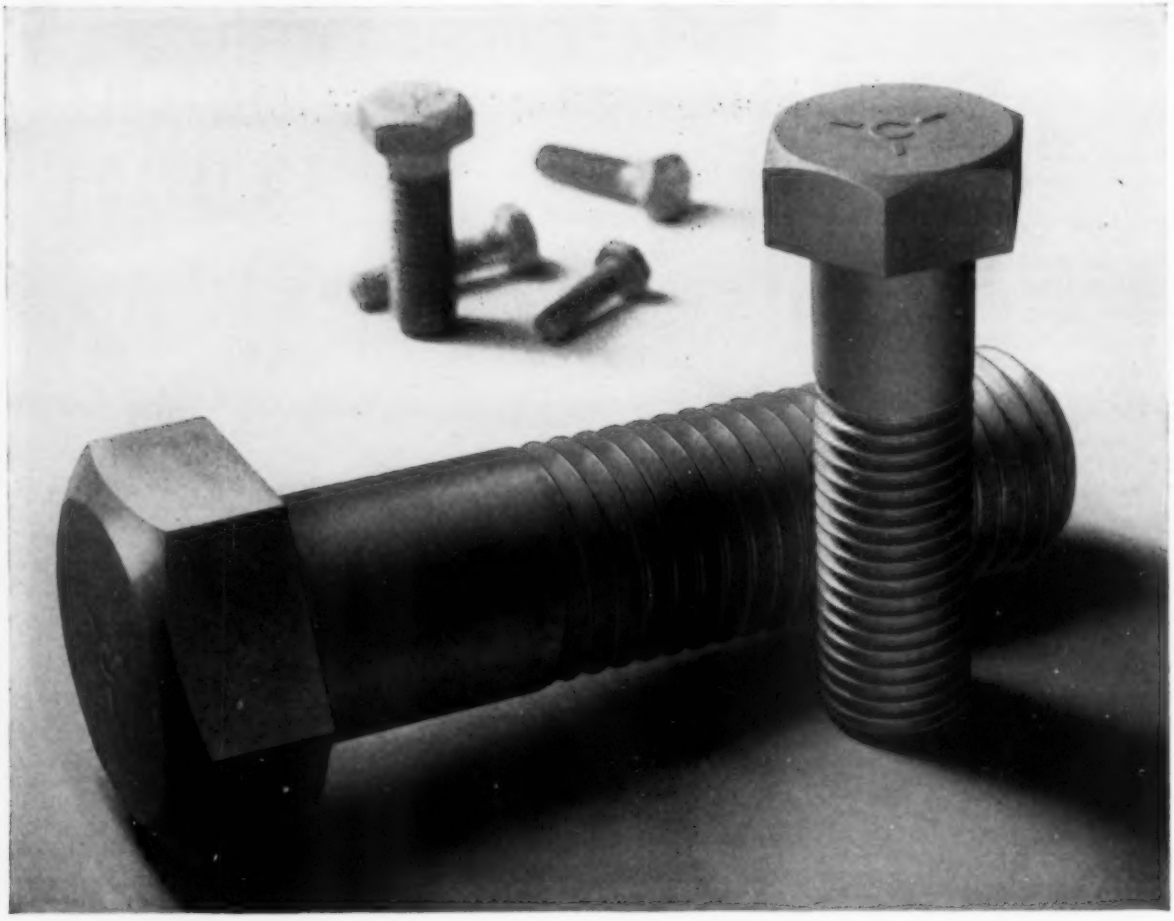

Cleveland upset forged hexagon head cap screws make your assemblies stronger and safer

Cleveland's upset forging process puts an extra measure of fastener muscle into your assemblies. The flow lines in every hexagon head cap screw follow the contour of the head, eliminating the planes of weakness along which shear might occur under the dynamic stress of heavy impact and vibration.

Cleveland hexagon head cap screws are manufactured from a wide variety of steels and in many different tensile strengths. In most cases, a Cleveland standard will serve as well as a special and will be much less expensive. Check the chart at the right for the one best suited to your needs. Then see your local Cleveland distributor. He stocks Cleveland hexagon head cap screws in sizes and physical properties to meet the most exacting demands of modern machinery design. All standard size cap screws in bright and quenched and tempered steels are available without delay—alloy steels on short notice. And remember, your distributor is backed by the most up-to-date production facilities and the largest factory stock of hexagon head cap screws in the world.

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Product	Size, in.	Tensile Strength, psi
Bright	Up to 7/8 incl. 1/2 to 1 1/8 incl. Over 1 1/8 to 1 1/2 incl.	85,000—105,000 75,000—100,000 65,000 min.
Quenched & Tempered (SAE Grade 5)	Up to 1/4 incl. Over 1/4 to 1 incl. Over 1 to 1 1/2 incl.	120,000 min. 115,000 min. 105,000 min.
Quenched & Tempered (SAE Grade 6)	Up to 3/8 incl. Over 3/8 to 3/4 incl.	140,000 min. 133,000 min.
Alloy (SAE Grade 7)	Up to 1 1/2 incl.	130,000 min.
Alloy (SAE Grade 8)	Up to 1 1/2 incl.	150,000 min.
Bright	Over 1 1/2 to 2 1/2 incl.	55,000 min.
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Note: Higher physicals, through use of selected alloys, can be supplied on special order.

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More POWER with Less Amps!

Century Performance-Rated® FAN MOTORS

HELP SOLVE YOUR LOAD AND POWER FACTOR PROBLEMS

In air conditioning or ventilating equipment, you can reduce starting current, reduce running current and increase power factor with these new Century Fan Motors. They are Performance-Rated for air conditioning manufacturers who are faced with new load and power factor problems. Fan manufacturers find advantages in their short length, light weight, multi-speeds and easy reversibility.

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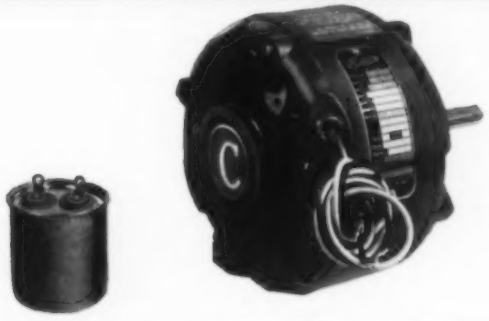
Type C, Permanent Split Capacitor . . . round frame, single speed, reversible—also available with cushion mounting.

Type CM, Permanent Split Capacitor . . . round frame, 2 or 3 speeds, all reversible—also available with cushion mounting.



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CORPORATION
BAYONNE, NEW JERSEY

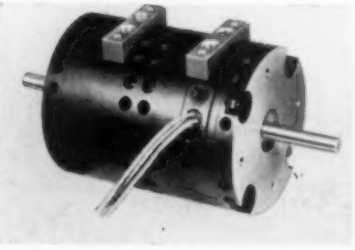
tion. These solenoids are designed for d-c operation only, sealed pull up to 1 lb, intermittent duty. Anderson Controls, Inc., 2777 Mannheim Road, Des Plaines, Ill.

For more information—
Circle 83, inside back cover

Hermetically Sealed Miniature Relay

A Class 11 six-pole, double-throw relay with built-in full wave rectification in a hermetically sealed enclosure is said to afford operation that closely approaches d-c from all frequencies up to and including 400 cps. Dimensions of container, less 20-pin miniature plug-in header and mounting studs: $2\frac{3}{8}$ x $1\frac{53}{64}$ x $1\frac{7}{32}$ in. Magnecraft Electric Co., 3350 W. Grand Ave., Chicago 51, Ill.

For more information—
Circle 84, inside back cover

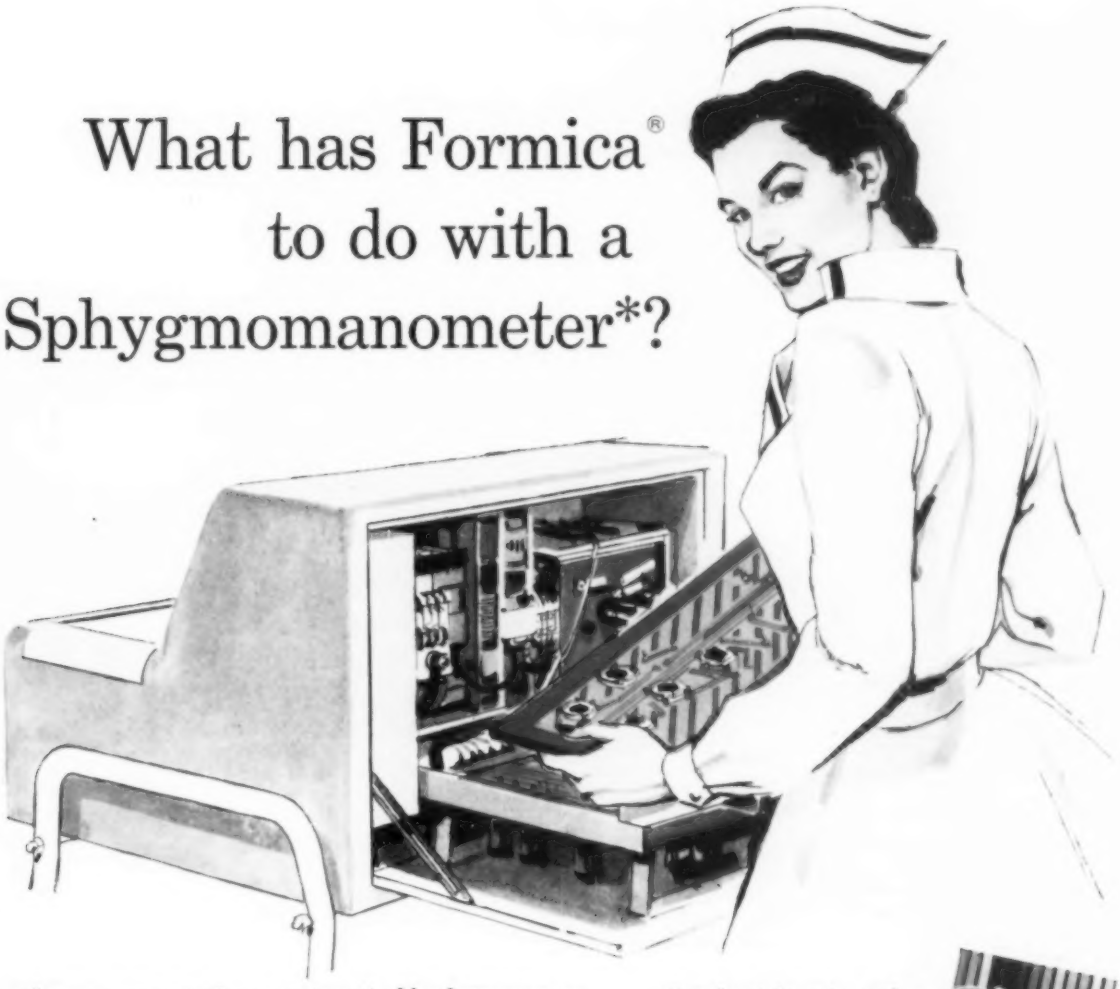


High Frequency Motor

A 400-cps a-c motor with double-end shaft originally designed for aircraft delivers $\frac{1}{3}$ hp continuously up to 50,000 ft altitude. Of the induction

(Continued on page 310)

What has Formica® to do with a Sphygmomanometer*?



This sphygmomanometer* – or automatic blood pressure recorder, if you prefer – demonstrates how Formica XXXP-36 copper clad laminated plastics is being used in a versatile printed circuit application.

In this case, a printed circuit provides the absolute interchangeability of parts in the field which simplifies and reduces the cost of field service on complicated electronic products.

The application versatility of Formica XXXP-36 then can be applied to many different kinds of electrical and electronic applications. You'll benefit especially from Formica-4 – the complete laminated plastics service that cuts engineering time, reduces component parts costs and assures delivery schedules for mass production operation.

FORMICA 4
CYANAMID

(1) Application Engineering
(2) Research
(3) Fabricating
(4) Customer stock service

FI-1543

Complete information on how Formica Laminated Plastics serves product designers in every field is contained in this 20-page Technical Catalog. Send for your free copy.

Formica Corporation
4516-7 Spring Grove Ave. Cincinnati 32, Ohio

Please send me a free copy of Formica Technical Catalog form 627.

Name_____

Company_____

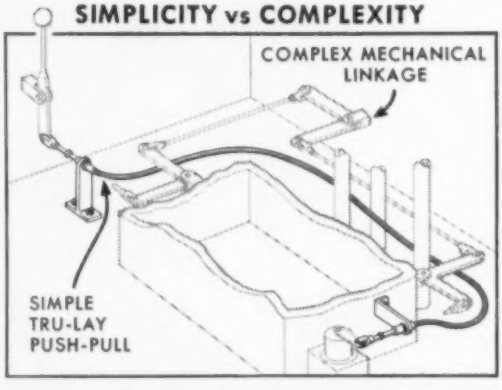
Title_____

Address_____

City_____ Zone_____ State_____

Design Engineers find PUSH-PULL Controls eliminate complicated mechanical linkages

SIMPLICITY vs COMPLEXITY



Compare the TRU-LAY PUSH-PULL cable in the illustration with the mechanical linkage. PUSH-PULLS are simple, have but one moving part, are noiseless and give lifetime service accuracy. Linkages are complex, made of many parts and wear at many points. Their use brings increasing backlash, lost accuracy and vibration.

USED AS A DOOR INTERLOCK IN HIGH-VOLTAGE CABINET

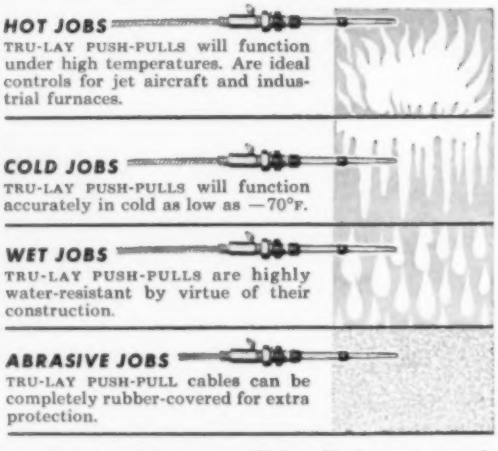
TRU-LAY PUSH-PULL cable insures high-voltage load is OFF before door can be opened.

Saves Space because it is flexible as a wire rope and fits easily into limited space.

Easy to Install with a simple clip where loads are light—clamped at the conduit fittings with a machined bracket.

Economical because it requires no maintenance. We have never known a TRU-LAY PUSH-PULL to wear out in normal use.

VERSATILE TO MEET THE TOUGH JOBS



HOT JOBS TRU-LAY PUSH-PULLS will function under high temperatures. Are ideal controls for jet aircraft and industrial furnaces.

COLD JOBS TRU-LAY PUSH-PULLS will function accurately in cold as low as —70°F.

WET JOBS TRU-LAY PUSH-PULLS are highly water-resistant by virtue of their construction.

ABRASIVE JOBS TRU-LAY PUSH-PULL cables can be completely rubber-covered for extra protection.

TRU-LAY PUSH-PULLS will handle heavy, tough jobs with up to 1000 lbs. input. They are effective controls for remote jobs 150 feet or more from the control point. They are frequently and successfully used in conjunction with electric, hydraulic and pneumatic controls.

CHECK THESE FEATURES AGAINST YOUR REQUIREMENTS

ADAPTABILITY • Approximately 80% of installations are met by standard anchorages, fittings and heads. Simple modifications meet almost every design requirement.

ACCURACY • TRU-LAY PUSH-PULLS are precision-built products. Accuracy is inherent in the basic design and standards of quality.

TROUBLE-FREE • TRU-LAY PUSH-PULLS are sealed against the entrance of dust, dirt or other foreign matter. The inner working member is lubricated for life.

LONG LIFE • Every feature of TRU-LAY PUSH-PULL construction makes these controls strong, highly resistant to stretch and compression, yet extremely flexible. None has ever worn out in normal service.

The six bulletins and booklets in the **DATA FILE** *will answer many questions on* PUSH-PULLS. *Write for your copy.*

Push-Pull DATA FILE

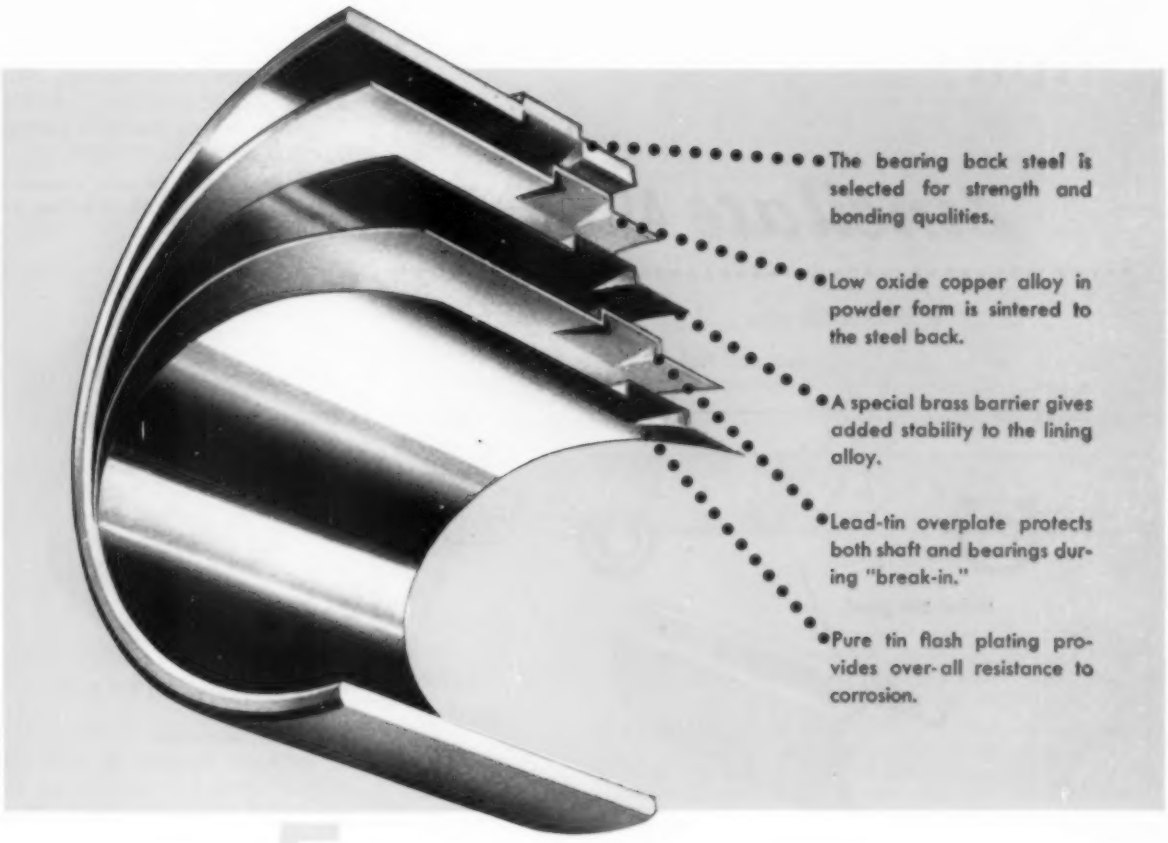
ACCO

AUTOMOTIVE and AIRCRAFT DIVISION

AMERICAN CHAIN & CABLE

601-E Stephenson Bldg., Detroit 2
2216-E South Garfield Ave., Los Angeles 22 • 929-E Connecticut Ave., Bridgeport 2, Conn.

TRADE MARK


The bearing back steel is selected for strength and bonding qualities.
Low oxide copper alloy in powder form is sintered to the steel back.
A special brass barrier gives added stability to the lining alloy.
Lead-tin overplate protects both shaft and bearings during "break-in."
Pure tin flash plating provides over-all resistance to corrosion.

The 5-layer bearing that set new performance standards

Development of our low oxide copper-lead powder made possible the type of bearing essential for today's high-speed and heavy-duty engines. In this powder, each dust-like granule is a balanced alloy of copper and lead, *in controlled proportion*. This is the "ingredient" that creates greater bearing load-carrying capacity needed in high speed, high temperature engines. If you would like to know more about Federal-Mogul copper-lead alloy and its different applications, address:

FEDERAL-MOGUL DIVISION

Federal-Mogul-Bower Bearings, Inc.

11043 Shoemaker, Detroit 13, Michigan

Rolled, Split Bushings

Bimetal Bushings

Spacer Tubes

Bearing-surfaced Thrust Washers

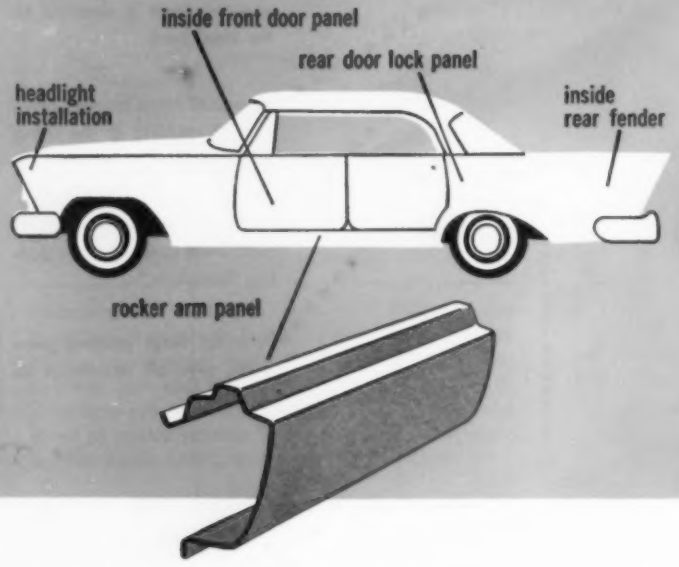
FEDERAL Mogul

SINCE 1899

RESEARCH · DESIGN · METALLURGY · PRECISION MANUFACTURING

NOW! a weldable corrosion-resistant coating

Zincilate 400



IT'S NEW! Zincilate 400 was used first by the automotive industry on the late 1956 models.

IT'S PROVED! Zincilate 400 is now being used by more manufacturers, in more crucial areas, on the 1957 models.

IT'S EXCLUSIVE! Only Zincilate 400 can be applied before fabrication, then welded, minutes or months after application. You'll get fast, clean work — anytime — when you weld over a Zincilate 400 coating, because it retains its conductivity and contains no chemicals to contaminate electrodes. And, note this — Zincilate 400 provides galvanic protection, even at the point of burn-off, that keeps corrosion shackled.

You can use Zincilate 400 on your product, applying it as the automotive people do, by spray, brush or dip, before fabrication and welding. Your product, if it's made of metal, will be protected — always — by Zincilate 400.

Cost? You'll find many coatings with a lower first cost. But overall costs, where it really counts, are lowest when you're using Zincilate 400. If you'll outline your problem, we'll be happy to tell you just what you can expect of Zincilate 400—and there's no obligation.

Zincilate

CORROSION-RESISTANT, ABRASION-RESISTANT, WELDABLE, AIR-DRIED and BAKED PROTECTIVE COATINGS

INDUSTRIAL METAL PROTECTIVES, INC., 404 HOMESTEAD AVE., DAYTON 8, OHIO

design, the motor operates at 5600 rpm on three-phase, 400 cps, 200 v a-c. Its weight is 4½ lb. U.S. Electrical Motors Inc., Box 2058 Terminal Annex, Los Angeles 54, Calif.

For more information—
Circle 85, inside back cover

Blower Moves 17 Cfm

Overall dimensions are 3½ x 2⅞ x 3¾ in. high. Operates at 3000 hpm (free air) from 115 v a-c 60 cps, and draws 10 w. The total weight is 22 oz. Minarik Electric Co., 224 E. 3 St., Los Angeles 13, Calif.

For more information—
Circle 86, inside back cover

Pneumatic Speed Transmitter

This speed transmitter produces a pneumatic output linearly proportional to rotational speed. It will measure the speed of any rotating machinery and is applicable to turbines, conveyor lines, compressors and mill equipment.

The transmitter operates on the force balance principle with magnetic

(Continued on page 314)

New!

DPS Connectors for High Altitudes-Vibration

These rack/panel pressurized connectors are designed for high altitude and vibration applications. When the DPS connector is mated, it is sealed about the insert faces by means of a specially designed rubber seal, that allows an axial tolerance of up to 1/8" while still effecting a seal. This seal is encased in the #34 shell so that the step down design of the mating #33 shell seats into and against it. In addition, the #34 or pin insert shell encloses a monobloc silicone insert designed so that the tightening of the junction shell effects a compression seal around the wires that have been inserted. The #33 or socket insert shell has a plastic front insulator, to insure alignment of contacts, and is backed up by a silicone rear insulator that is also tapered to permit the corresponding taper of the junction shell to compress it around the wires as the junction shell is tightened. Contacts for DPS connectors must be ordered separately, and installed at time of wiring. Co-axial contacts, and thermocouple contacts are available. Also, air lines. DPS connectors are available in 4 different sizes with several insert arrangements for each size.

Write for Bulletin DP-101 TODAY!

WHAT'S NEW FOR YOU

New!

Coaxial Connector Screw Type Coupling

TNC Coaxial Receptacle SA-445

Latest RF Connector Series — The TNC. The TNC is a screw type coupling version of the improved BNC series for small coaxial connectors. This TNC series, made by the Eastern Division of Cannon Electric, is available in two types: low voltage and high voltage. Both types are ideal where minimum noise is desired. They are lightweight, waterproof, sealed connectors which will operate at any altitude.

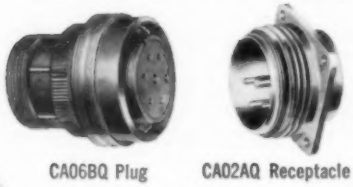
The high voltage TNC is recommended for AC rating up to 5,000 volts. Low voltage rating is to 500 volts. The TNC series is also available with collet cable clamp.

Write for RF Coaxial Bulletin DC-1 TODAY!

IN CANNON PLUGS

New!

Quick-Disconnect Accessories for AN-Plugs



CA06BQ Plug CA02AQ Receptacle

An accessory that consists of coupler and an adapter has been recently perfected by Cannon to provide quick connect and quick disconnect characteristics to AN connectors.

The adapter is designed to screw over the coupling threads of a standard AN receptacle, and contains an external locking groove which receives the formed ends of the coupler latch when fully engaged. The entry of the coupler latch into this groove permits a compression spring to move the coupler sleeve forward, locking the parts securely. A simple straight pull back on the sleeve releases the latch and permits disconnection.

The coupler consists of a special spring latch assembly, and is designed to replace the coupling nuts on Cannon AN3106A and AN3106B plugs.

Write for Bulletin PR-QD TODAY!

CANNON PLUGS
WHERE RELIABILITY IS THE 5TH DIMENSION

CANNON ELECTRIC

Please refer to Dept. 106

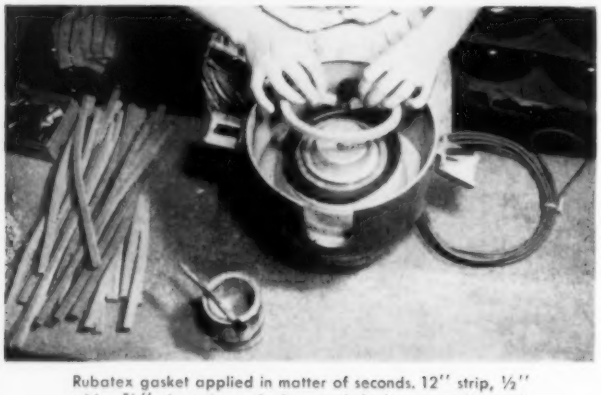
CANNON ELECTRIC CO., 3208 Humboldt St., Los Angeles 31, California. Factories in Los Angeles, Salem, Mass., Toronto, London, Melbourne. Manufacturing licensees in Paris, Tokyo. Representatives and distributors in all principal cities.

PROSPERITY CHOOSES RUBATEX vs "SPONGE" FOR NEW REXAIR CLEANER

"In the manufacture of our new Rexair Cleaner and Conditioner, we found a leakproof gasket was needed between the water pan and the motor. A regular sponge rubber could not be used because it would soak up water and eventually reach the saturation point, spilling water out of the machine.

"Rubatex was chosen for this job because of its resilience and its closed cellular construction which makes it a perfect water seal for this application."

Francis P. Hodgkinson
Director of Engineering
The Prosperity Company, Inc.
Syracuse, New York



Rubatex gasket applied in matter of seconds. 12" strip, ½" wide, 7/16" deep, is made into a circle by cementing ends together. Circular piece is easily fitted and cemented into groove between water pan and motor.

Breakdown of the Rexair showing water pan at left. Also closeup of interior of Rexair Cleaner with Rubatex gasket in place around motor base.

The switch to Rubatex is becoming common practice in industries in need of a positive gasketing and sealing material.

Its closed cellular structure, composed of millions of individual nitrogen-filled cells, permanently sealed with tough, live rubber, gives Rubatex unusual resilience and unequaled ability to repel moisture indefinitely and shut out oxygen, dust and dirt even at cut edges.

Here's a material that's been tried and tested for over 20 years in automotive, aircraft, radio, electronic, refrigeration, air conditioning and appliance applications. It will pay you to check the advantages of Rubatex for your job, too.

RUBATEX
CLOSED CELLULAR RUBBER
LEAKPROOF GASKETS

RUBATEX DIVISION, Dept. P-7
GREAT AMERICAN INDUSTRIES, INC.
Bedford, Virginia

For full details and sample of the new Rubatex Closed Cellular Rubber Leakproof Gaskets—print your name in space below, attach to your company letterhead and mail to us.

Name _____

Send for Free Sample and full details

DOUBLE BALL BEARING TUBULAR EQUIPMENT CASTER

for • Dish Carts
• Beds
• Bassinets, etc.

SERIES **EA**

DOUBLE BALL BEARING TUBE AND ANGLE IRON CASTERS

for • Sweepers
• Display Racks
• Portable Washers, etc.

SERIES **EW**

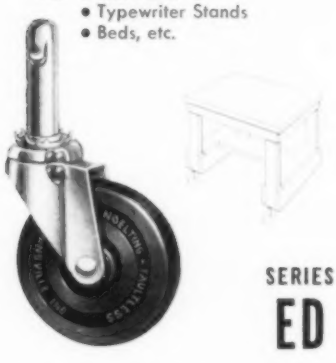
DOUBLE BALL BEARING PIVOT BEARING STEM TUBULAR EQUIPMENT CASTER

for • Metal Chairs
• TV Stands
• Metal Tables, etc.

SERIES **ES**

DOUBLE BALL BEARING WOOD EQUIPMENT AND FURNITURE CASTER

for • Dish Carts
• Typewriter Stands
• Beds, etc.



SERIES **ED**

DOUBLE BALL BEARING SWIVEL PLATE CASTERS

for • Dollies
• Workshop Tools
• Utility Trucks, etc.

SERIES **EP**

DOUBLE BALL BEARING THREADED STEM CASTERS

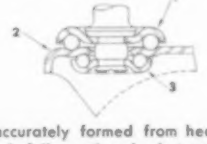
for • Safety Ladders
• Grocery Carts
• Garment Racks, etc.

SERIES **EY**

ALL "E" SERIES CASTERS FEATURE THE FAULTLESS 3-PIECE DOUBLE BALL BEARING SWIVEL

Faultless Double Ball Bearing Swivels are made with *two full rows* of hardened ball bearings rolling around *two separate* hardened and lubricated raceways.

1. Upper ball race—large diameter, precision formed, hardened raceway.
2. Center member—one-piece hardened horn swivels freely between 2 full rows of bearings.



3. Lower ball race—accurately formed from heavy gauge steel, hardened, fully enclosed, dust-proof assembly.

For maximum caster movement from minimum effort, always specify Faultless Double Ball Bearing construction—developed and perfected by nearly three quarters of a century caster making experience. Write for catalog with full information.

each the *BEST* for its job!

Casters are highly specialized—in design, load capacity and in application. For every mobile unit there is a correct Faultless Caster size, stem or plate, rated load, kind of wheel. More than 10,000 different Casters are yours to choose from when writing specifications for a particular product. Drawing templates of many Casters are available for the convenience of your designers.

Simply tell us what you are engineering and, with no obligation on your part, we will gladly send catalog material on those Casters considered most suitable for your use.

NØELTING **Faultless CASTERS**

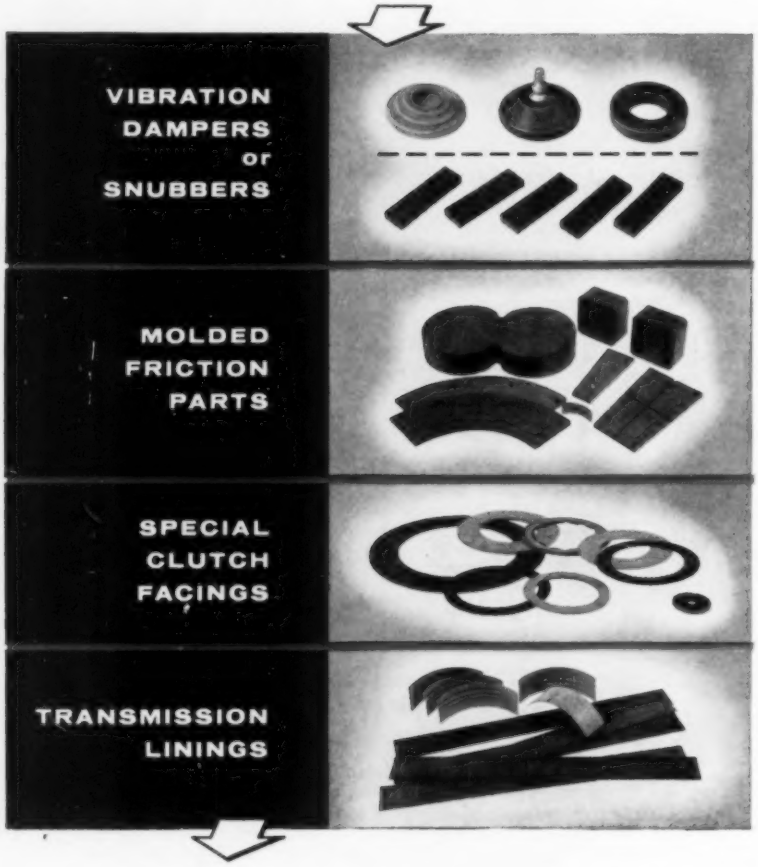
FAULTLESS CASTER CORPORATION
EVANSVILLE 7, INDIANA

Offices in Atlanta, Baltimore, Boston, Buffalo, Chicago, Cleveland, Dallas, Detroit, Grand Rapids, High Point, Indianapolis, Los Angeles, New Orleans, New York, Philadelphia, Portland, Seattle, St. Louis. Canada: Stratford, Ontario.

let **WORLD BESTOS**

help you

in the design and production of



● World Bestos offers you more than 30 years' engineering and manufacturing experience in the producion of molded friction parts. Chances are our immense resources and facilities can supply you with molded parts and friction components—to meet your requirements—at a savings in both time and money.

● Send your blueprints (or samples) for prices and delivery information to WORLD BESTOS, Industrial Products Section, New Castle, Ind., Phone: 2360. Write for free illustrated folder.

WORLD BESTOS NEW CASTLE, INDIANA

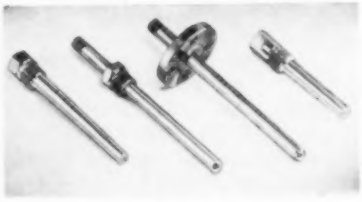
DIVISION OF THE Firestone TIRE & RUBBER COMPANY

Industrial and Automotive Brake Blocks and Linings • Transmission Linings • Special Clutch Facings • Vibration Controls • Sheet Packing

actuation of a standard pneumatic circuit. Connected to rotating equipment, the transmitter input shaft spins a multi-pole permanent magnet, rotating a magnetic field through a non-magnetic disc close to the magnet poles. The disc, with a force bar attached, tends to rotate in the same direction as the magnet, positioning the bar in relation to an air nozzle.

The resulting back pressure in the nozzle circuit, amplified by a relay, exerts force, through a free-floating ball piston which bears on the force bar, to balance the torque produced on the disc by the rotating magnet. This 3 to 15 psig feedback pressure is received by an indicator, recorder or controller calibrated in units of speed. Transmitter range is adjustable from 0 to 1600 rpm, up to 0 to 2400 rpm by an adjustment screw. The range is extended to 0 to 320 rpm through 0 to 5300 rpm by optional speed changers. Instrument can be assembled to measure clockwise or counter-clockwise rotation, or the 3 to 15 psig output can be split to accommodate both forward and reverse rotation within the maximum range limit. Foxboro Co., Foxboro, Mass.

For more information—
Circle 87, inside back cover



Thermocouple Housings

Both bar stock and built-up units are available to provide a means of protecting thermocouples against mechanical injury and corrosive or contaminating atmospheres. Choice of a wide range of alloys provides protection against high temperature, oxidation or reduction, chemical corrosion, metallic amalgamation, mechanical shock or stress, and sudden temperature change.

Bar stock wells are drilled by the rifle boring process with bore concentricity guaranteed within 10% of wall thickness. They are available flanged, threaded, with hex head or wrench flats, or with ground joints. Built-up

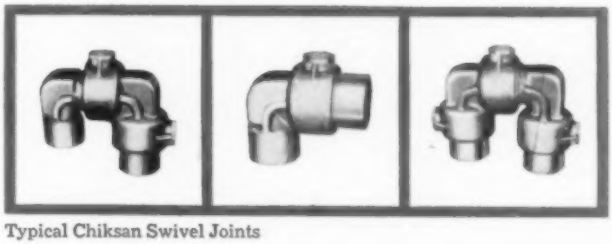
(Continued on page 318)

PROBLEM: TORSION FATIGUE ON RUBBER HOSE

SOLUTION: CHIKSAN SWIVEL JOINTS

When twisting and kinking on hose lines present a torsion fatigue problem, look to Chiksan for a ready solution. Chiksan Swivel Joints, with free turning 360° rotation allow hose lines to be flexed without the twist caused by fixed position fittings. With Chiksan Swivel Joints hose lines last longer, maintenance and downtime are virtually eliminated.

Call on Chiksan, depend on Chiksan. Over 1000 different types, styles and sizes have been developed for pressures from 28" vacuum to 15,000 psi and temperatures of −70° to +225°F. A nearby representative is ready to analyze your requirements and make specific recommendations. Write today for his name.



Typical Chiksan Swivel Joints

WRITE FOR DESCRIPTIVE CATALOG
Dept. 206

CHIKSAN

A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION fmc

CHIKSAN COMPANY–BREA, CALIFORNIA • CHICAGO 5, ILLINOIS • NEWARK 2, NEW JERSEY

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Subsidiaries: Chiksan Export Company • Chiksan of Canada, Ltd.

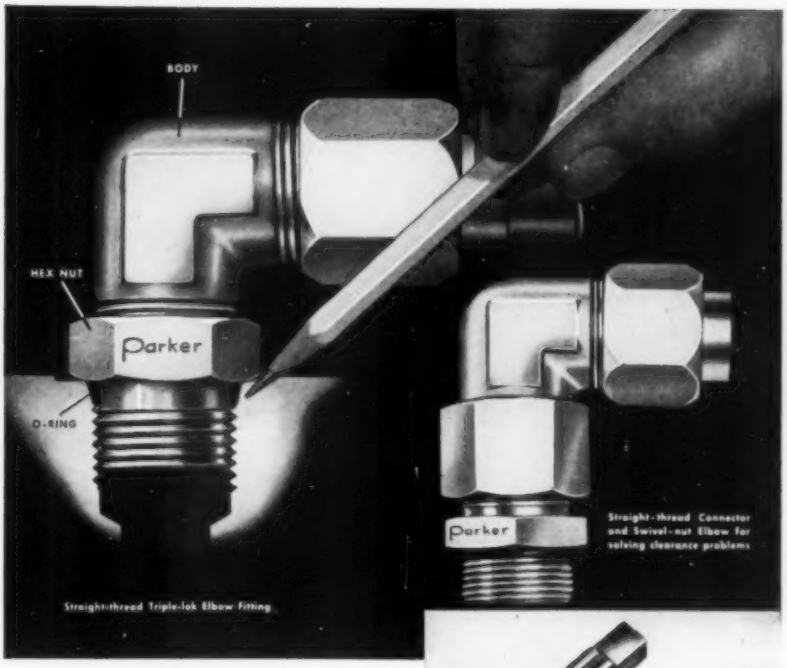
The bearings you need when you need them

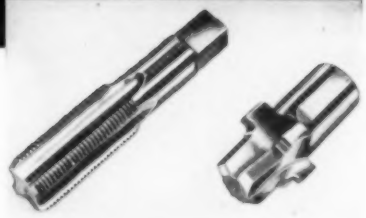
Whatever your ball bearing needs, investigate the advantages BCA offers. You get engineering assistance based on nearly 50 years' experience designing and manufacturing ball bearings . . . production flexibility to handle both emergency and routine situations . . . delivery when promised to keep your production lines moving. When you do business with BCA, you get the bearings you need . . . when you need them. Bearings Company of America Division, Federal-Mogul-Bower Bearings, Inc., Lancaster, Pa.

FREE! BCA "Engineering Handbook." Available to engineers without cost. Write on your company letterhead.

BCA Division

Federal-Mogul-Bower Bearings, Inc.





Precision thread-tapping and counterboring tools for making accurate *straight*-thread boss (to receive these new Parker *straight*-thread fittings) are now available with machining drawings from Parker.

New Parker *straight*-thread fittings solve your leakage problems

Now you can forget about high-pressure hydraulic problems resulting from tapered pipe threads. Forget about leakage . . . about the danger of cracking or distorting valve bodies by over-tightening the fittings . . . about damaged threads from over-tightening to obtain proper positioning. Forget about messy pipe "dope".

You can eliminate all of these problems by using new Parker *straight*-thread fittings with positive O-ring seals. (See illustration above.)

Parker *straight*-thread fittings are now being supplied in response to the growing demand for this new type of leakproof, trouble-free connection. They are shorter and have smaller hexes than the AN fitting for the old AND 10050 boss. *Straight* threads are available on *Triple-lok* (the industrial standard flare tube fitting) and on *Ferulok* (flareless fitting for heavy steel tubing).

This is another example of Parker's pioneering leadership in the field of hydraulic fittings. Write for Catalog.

TUBE AND HOSE FITTINGS DIVISION
Section 417
The Parker Appliance Company
17325 Euclid Ave., Cleveland 12, Ohio

Parker
Hydraulic and fluid system components

Now enjoy advantages of rubber-covered hose without stripping . . .

Use new Parker NO-SKIVE fittings

Stop stripping hose covers! New NO-SKIVE *Hoze-lok* fittings require no stripping of rubber-covered hydraulic hose. They're faster, easier-to-use . . . *and re-usable.*

Two simple steps complete the make-up: (1) Dip end of hose in oil and screw into socket counter-clockwise until hose reaches end of recess in socket. (2) Dip nipple in oil and push into socket and hose, turning clockwise to engage thread. Screw all the way in.

During step (1), the lead thread of the socket cuts through the rubber cover of the hose. This permits the threads following it to contact and grip the wire braid. It will hold beyond hose-bursting pressures . . . also under severe vibration conditions.

Send for Bulletin 4433. Mail the coupon for complete information about these new Parker *Hoze-lok* fittings. Find out how you can simplify and speed your hose assemblies.

TUBE & HOSE FITTINGS DIVISION
Section 417
The Parker Appliance Co.
17325 Euclid Ave.
Cleveland 12, Ohio

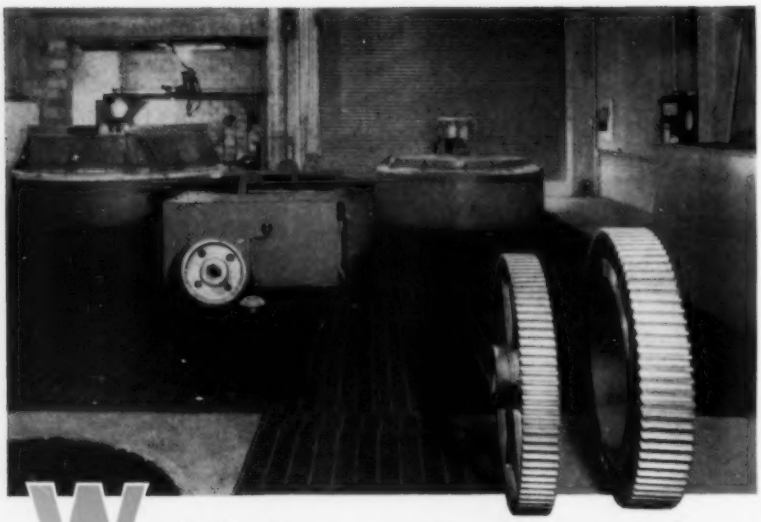
☐ Please send me your new Bulletin 4433 about NO-SKIVE Parker Hoze-lok fittings.

Name_____

Company_____

Address_____

City State



World's largest Radiant Tube Pit-type Carburizer installed at

...more precise heat treatment for larger gears

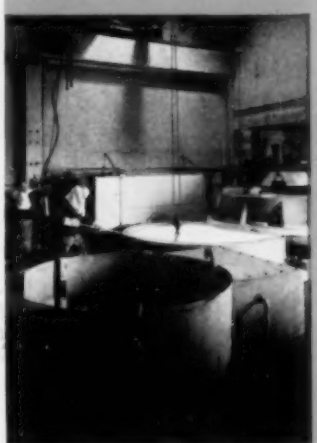
• New heat-treating equipment, including the largest radiant tube pit-type gas carburizing furnace ever built, has recently been installed in the Pittsburgh plant of our subsidiary, Pittsburgh Gear Company. These new additions to BRAD FOOTE's extensive heat-treating equipment provide facilities for the most advanced techniques in deep case carburizing and hardening in controlled atmospheres.

• The new carburizer can handle gears or machine parts up to 6 feet long, 6 feet wide and up to 8500 pounds in weight. In addition to its size, the new equipment has an unusual ability to control carbon penetration, giving extremely precise control of the depth of surface hardening.

• Special heat-treating equipment, like this new carburizer, allows BRAD FOOTE to impart the precise metallurgical characteristics which make for longer wear, shock resistance and freedom from distortion in gears of all sizes and types. And BRAD FOOTE heat-treating is under the supervision of metallurgists with long experience in the special problems of the gear industry.

• Whether you want one gear or ten thousand, BRAD FOOTE's extensive facilities and specialized skills are at your disposal. Send us the specification on your next problem job for quotation. No obligation, of course.

BRAD FOOTE



BRAD FOOTE MAKES

Spur • Bevel
Helical • Spiral Bevel
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Zerol • Worms
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subsidiaries

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Phone: Lemont 920
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wells of seamless pipe are available with threaded mounting bushings or flanges. Thermo Electric Co., Saddle River, N. J.

For more information—
Circle 88, inside back cover

Aircraft Circuit Breakers

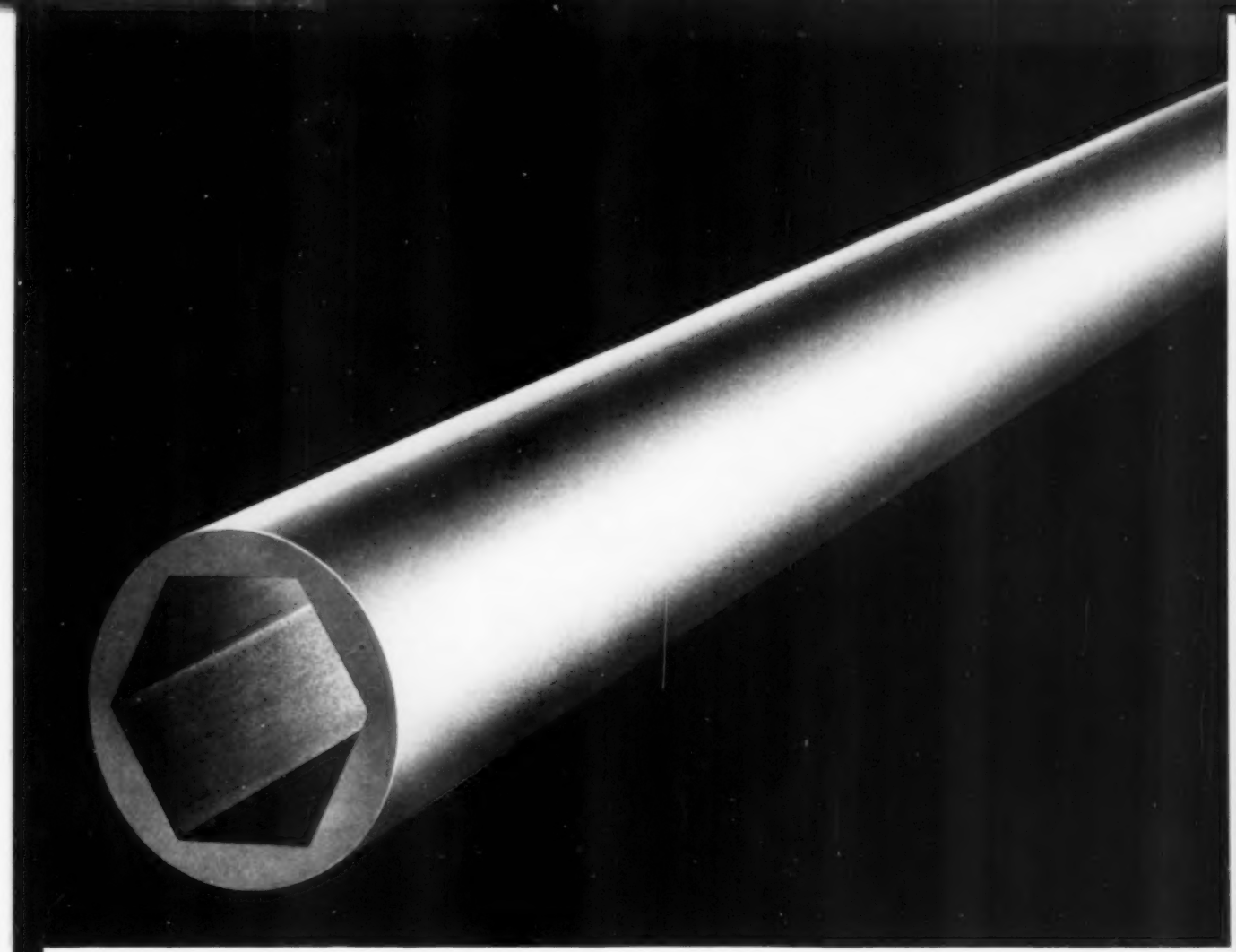
Miniaturized circuit breakers each weighing less than 1½ oz have three moving parts: actuator, slide, and thermal disc. They are available with either toggle switch or a push-pull actuator. Rupture capacity is over 4000 amp, 120 w, a-c. Spencer Thermostat Div., Metals & Controls Corp., Attleboro, Mass.

For more information—
Circle 89, inside back cover

Keyboard Pushbutton Switch

The switch was developed for rapid-repeat, one-finger operation such as found in the keyboards of electric typewriters, adding machines and sim-

(Continued on page 322)



EVER TRIED MACHINING A SPECIAL I.D. SHAPE?

—in stainless steel, with each part 22 inches long, the outside diameter a shade over 2 inches and with tolerances of +.000" to −.010" across the flats?

On jobs like this, there's possible trouble ahead if you start with solid stock, or even round heavy wall tubing. Machining problems, surface finishing, scrap loss, special cutting oils or compounds—added to the original stock cost may make the final cost of the part prohibitive.

There is one sure way of minimizing your production problems and costs involving hollow cylindrical parts and products—*DESIGN WITH B&W MECHANICAL TUBING.*

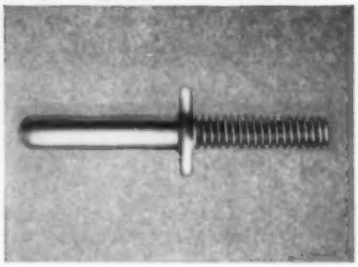
Before you start your next production run, call Mr. Tubes at your nearby B&W Tubular Products Division District Sales Office—let him match tubing steels, types, finishes, shapes and tolerances to your applications—he will show you how to keep final costs low. Or write for bulletins 361 and 340. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

TA-6086-M2

Seamless and welded tubular products, seamless welded fittings and forged steel flanges—in carbon, alloy and stainless steels.

National SPECIAL PRODUCTS SERVICE

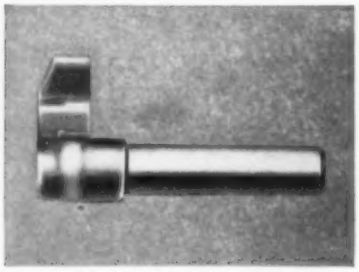
Precision parts with closely held tolerances and excellent surface finish, like this, can also be cold headed more economically and quickly.



Small parts like this can be produced, by cold heading, in huge hourly volume and at low unit cost.

Get strength at low cost with

COLD HEADED SPECIALS!



Intricate formations, like this, difficult or too costly by other methods, become routine production in the cold heading process.

You can make remarkable savings and get better parts in many cases by letting us duplicate and improve on parts you previously have had machined, cast or forged. It's possible with National cold heading!

What's more, we can quickly tell you whether cold heading would be an advantage for new designs.

Here's how National cold heading reduces unit costs . . . gives you better parts!

You save on production costs, because cold heading is fast . . . production rates of 50 to 300 pieces per minute are common. You don't pay for waste. Scrap loss in cold heading is negligible. You save on cost of extra operations, because cold heading eliminates them entirely or reduces their number. And most secondary operations, when required, can be performed automatically in mass production.

Cold heading assures strong, sound parts with good finish and excellent resistance to fatigue, shear and impact!

You're sure of strong parts because cold working *increases* the strength of steels and nonferrous metals. Subsequent heat-treatment or hardening can produce practically any degree of physical properties you desire.

You're sure of sound, clean parts because any defects, such as seams and inclusions, will open up in cold working . . . resulting in *automatic rejection.*

You're sure of superior fatigue, shear and impact resistance because cold heading produces continuous, unbroken flow lines in the grain of the metal . . . impossible to obtain by any other method.

You're sure of good surface finish, with a maximum of 50 micro-inch on cold headed surfaces. Cold heading won't cut or break the specially prepared, smooth, compressed and toughened surface of the rod.

National's cold heading specialists have many years of design and production experience. Combined with National's tremendous facilities for cold heading and secondary operations, this assures you of outstanding work and help in design and production of your parts.

Write for National's booklet, *Special Products.* To learn more about what National cold heading can do for you, send us your specifications or call in your nearest National representative.

THE NATIONAL SCREW & MFG. CO. • CLEVELAND 4, OHIO

***Pacific Coast:* National Screw & Mfg. Co. of Cal. • 3423 South Garfield Ave., Los Angeles 22, Cal.**

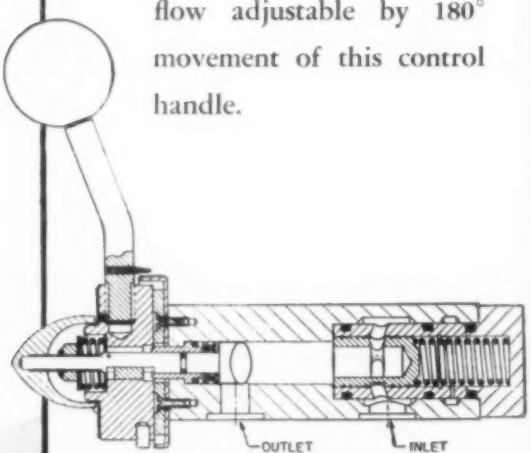
National PRODUCTS

Fasteners **Hodell Chains** **Chester Hoists**

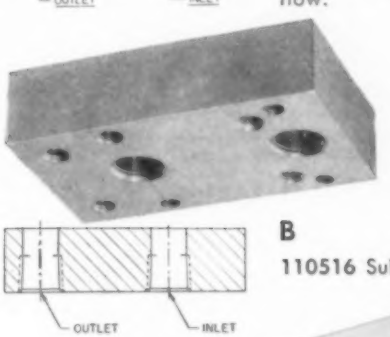
Another WATERMAN WINNER

Adjustable Flow Regulator

An adjustable flow regulator adapted for manifold mounting. Sub-plate kits are furnished with built-in check valves for free reverse flow. They are interchangeable, dependable, light-weight and easily installed. Either right or left hand rotation of control handle is available. Maximum or minimum flow adjustable by 180° movement of this control handle.



A
110534 Sub-Plate Kit with built-in check valve for free reverse flow.



B
110516 Sub-Plate Kit.

Write for illustrated bulletin E, describing the many valuable features of this Adjustable Flow Regulator.

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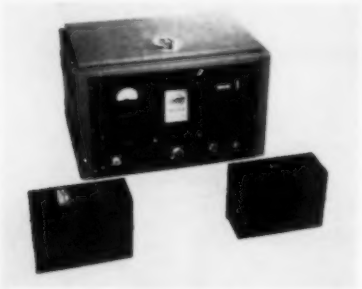
ilar equipment. A single-pole, double-throw subminiature basic switch is employed. Switch and actuator can be operated at frequencies up to 300 times per minute.

The switch is UL-listed at 5 amp, 125 or 250 v a-c. Micro Switch, div. Minneapolis-Honeywell Regulator Co., Freeport, Ill.

For more information—
Circle 90, inside back cover



Photoelectric Unit for Micro-lumen Range

A photoelectric instrument designed to detect light changes in the micro-lumen range is adjustable within a range of light change limits to meet specific requirements. In the broad sense the instrument is designed to detect deviations from normal configuration of solids, liquids, and visible gases passed before the eye of the unit.

Variations in wire, vapor, webs or filaments of any material may be automatically detected, counted, and, if desired, a stop-motion device actuated. The unit is said to detect a minute break of one of the filaments in nylon yarn with accuracy at all times across any distance up to 25 ft. Lindly & Co., Mineola, N. Y.

For more information—
Circle 91, inside back cover

Overload Protection for Electrical Motors

This electronic device can be used with any electrically driven equipment, such as mixers, agitators, conveyors, elevators, machine tools and pumps. According to the manufacturer, it responds immediately to any increase in drive-motor current. As soon as the overload is removed, it

(Continued on page 326)

Tough
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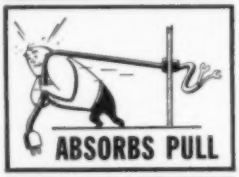
STRAIN RELIEF BUSHINGS

Insulate and anchor the power supply cord to your housing . . .

no need for grommets, wire knots or costly labor.



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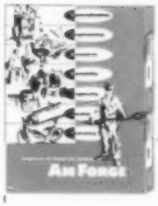

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PLASTICS NEWSFRONT

EYE-LURING COLOR CAPS BEST-SELLING PACKAGES

To compete for attention on crowded toiletry counters and shelves today, many best-selling products add a cap of colorful BEETLE® Urea Molding Compound. The beauty of color—any color—is permanently molded in. Closures of BEETLE Plastic are practical, too: they resist alcohol, acetone and other solvents, resist staining, and don't have an electrostatic affinity for dust, so stay clean longer on shelves.

NEW PIPE JACKET STOPS UNDERGROUND CORROSION

Strong jackets of spirally wrapped glass cloth and LAMINAC® Polyester Resin combat corrosion in new prefabricated insulated pipe conduit for underground steam and hot-water systems. Developed by Temploc, Inc., Baldwin Park, Calif., the protective two-ply shell is much lighter, less costly and more corrosion resistant than conventional steel or tar-protected conduit. Insulation is sealed and vapor-proofed at the ends by bonding the cloth-resin shell directly to the bare pipe. Field joints of insulation, cloth and resin are easily applied at the site.

IMPROVED HOUSING FOR NEW pH METERS

To make the housings for Pocket model and ZER O MATIC* bench model pH meters (shown) unusually strong, impervious to chemicals and resistant to scratching and chipping, Beckman Instruments, Inc., molds them of CYMEL® 1077 Melamine Molding Compound. This tough, break-resistant plastic protects the delicate mechanism and also provides the attraction of color without the added production steps required in finishing metal. Color is part of the housing itself; there is no coating to wear or chip off . . . no metal to corrode. *Trademark Beckman Instruments, Inc.

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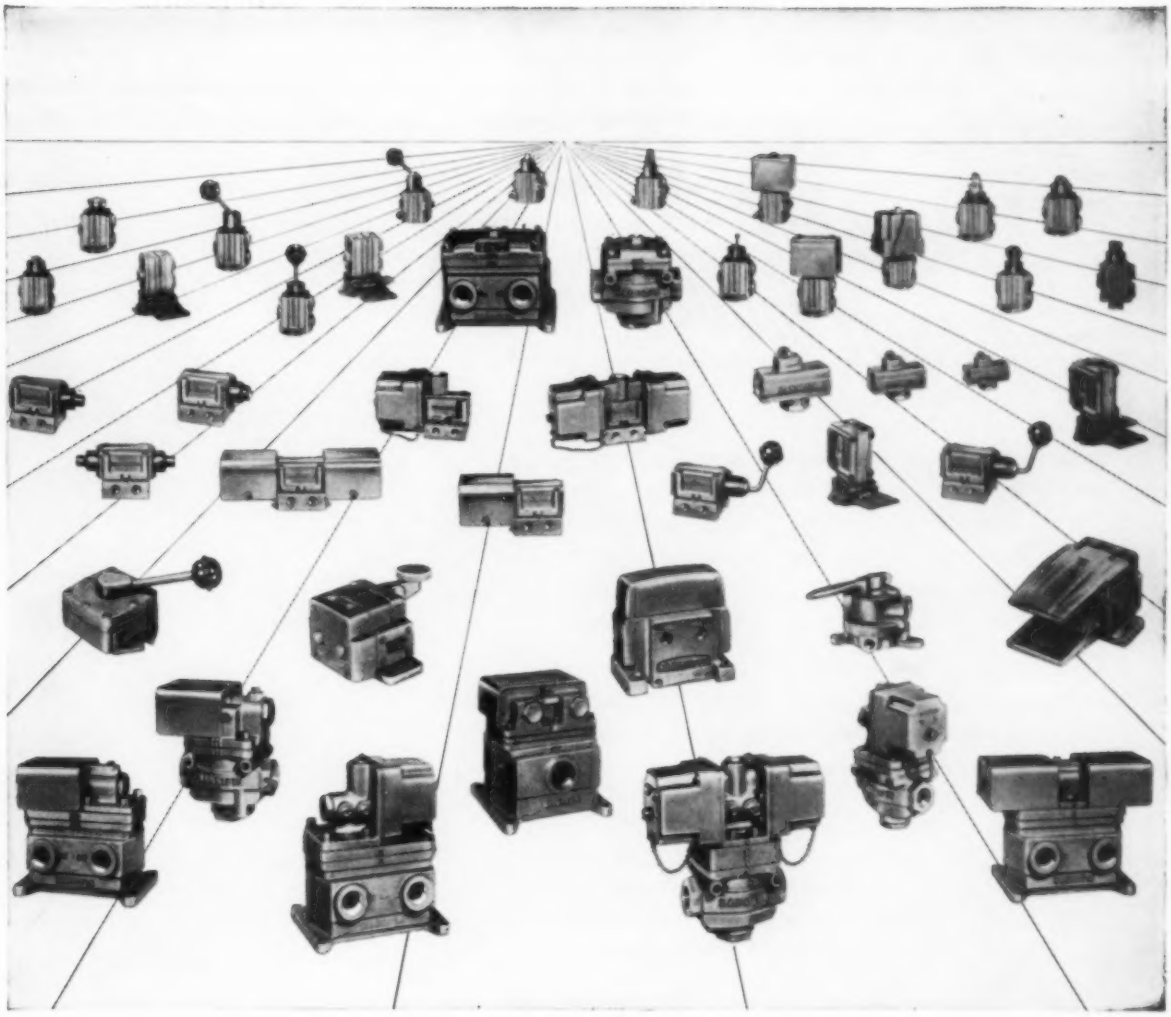
CYANAMID Plastics and Resins Division
MATERIALS FOR TOMORROW



These valves like tough jobs

Discriminating engineers are finding that out. More and more of them are specifying Hannifin valves for every kind of directional air control—including the really tough jobs.

There are plenty of reasons why: Inspired simplicity of design. Fewer parts—and *those* easily and quickly replaceable. Ability to serve a wide range of application with fewer valve models. And—above all—fast, smooth operation.

Your Hannifin man will gladly give you the whole story. We'll tell you where to get in touch with him—after you examine the big Hannifin catalog.

AIR CONTROL

HANNIFIN

VALVES

***For this complete catalog** showing all the Hannifin directional air control valves, write to Hannifin Corporation, 525 South Wolf Road, Des Plaines, Illinois.*

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...the best and most modern!

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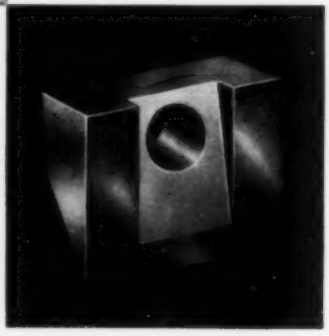
In an entirely new plant with the very latest equipment, Bunting now attains the position in the Sintered Powdered Metals field which it has long held in the field of Cast Bronze Bearings.

A competent group of Bunting Sales Engineers in the field and a fully staffed Product Engineering Department put at your command, comprehensive data and facts based on wide experience in the designing and use of Cast Bronze and Sintered Powdered Metal Bearings and parts.



Write for catalogs and your copy of the new 24 page Bunting Engineering handbook of Sintered Powdered products and their composition, manufacture and application.

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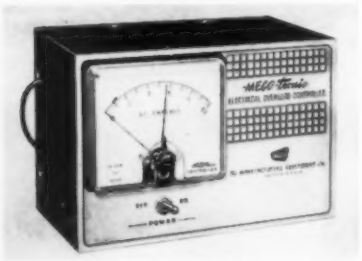
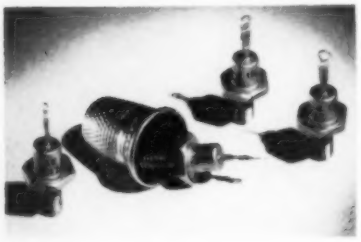


automatically allows the mechanism to operate.

The controller can be used with any size motor. One unit can be used to protect several motors. Manufacturers Equipment Co., 218 Madeira Ave., Dayton 4, Ohio.

For more information—
Circle 92, inside back cover



Stud-mounted Silicon Rectifiers

Silicon rectifiers (170C) for use in military and commercial equipment power supplies have peak inverse voltage ratings of 100, 200, 300 and 400 v with maximum rms voltage ratings of 70, 140, 210 and 280 v, respectively. They are designed for a maximum output of 600 milliamp at a case temperature of 150 C. General Electric Co., Syracuse, N. Y.

For more information—
Circle 93, inside back cover

Relay with Silicon Rectifiers

To resolve heat problems where miniature relays are used in high temperature applications, an a-c relay uses silicon rectifier assemblies which will withstand temperatures from −65 C to 125 C. The relay operates on 115 v, 60 to 400 cps.

These self-contained relays are available in six-pole, double-throw or four-pole, double-throw or 4 PDT models, with plug-in or solder-lug connections

(Continued on page 328)

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You'll find him eager to work with you on both design integration and test . . . at your plant or ours. Standardization, compact design and interchangeability of parts, makes it possible for Webster to increase or decrease capacity and vary porting without changing the mounting or necessary adapter plates. Over 100 different models solve most special problems on mobile drills, agricultural implements, industrial trucks, loaders, power steering, machine tools, construction and specialized machines.

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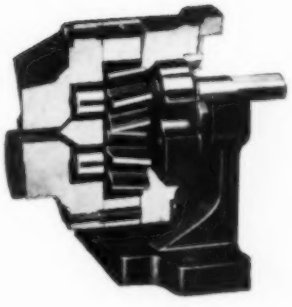

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- Please send the following -

☐ *Complete hydraulic catalog of pumps and valves*

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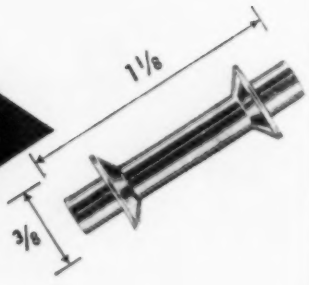
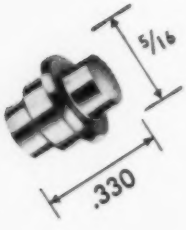
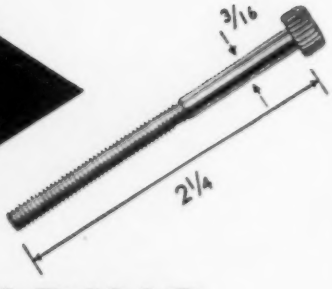
over machine method cost



SAVINGS
$12.35
PER THOUSAND
over machine method cost



SAVINGS
$6.80
PER THOUSAND
over machine method cost



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Cold-Heading is the most versatile, most economical method for producing your fasteners and small parts. These case histories are typical of thousands of money saving jobs we've done for our customers. May we quote on your requirements? Write today for the Hassall Catalog.

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FASTENERS AND SPECIALTIES

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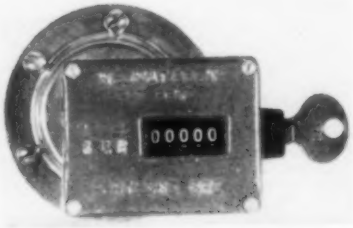
and standard mountings. Union Switch & Signal, div. Westinghouse Air Brake Co., Swissvale, Pa.

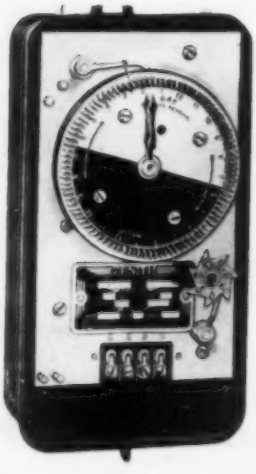
For more information—
Circle 94, inside back cover



Counter for Fluid Power Systems

Automatic counting devices for any operation controlled by pneumatic or hydraulic systems screw into the line controlling any air or hydraulic cylinder. There is said to be no linkage to assemble or get out of adjustment, no solenoid, and no possibility of miscounts. Pneumaticount, 3400 N.E. 54 Ave., Portland, Ore.

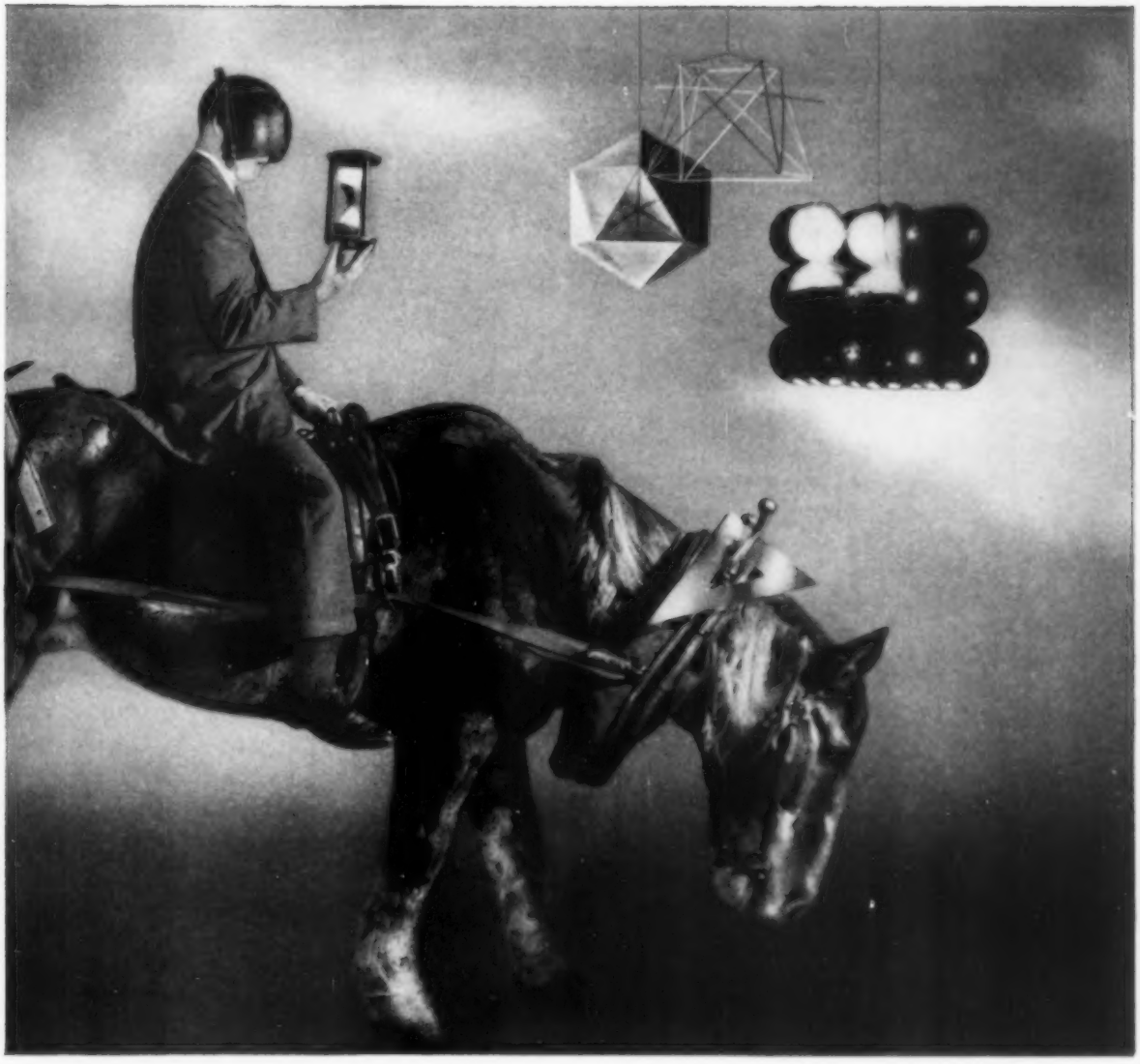
For more information—
Circle 95, inside back cover



Multiple-Operation Time Switch

Automatic control of intermittently operated equipment is provided by a 24-hr time switch. The switch will handle as many as 48 "on" and 48 "off" operations in one day. Typical operations on which it can be used include oil wells, heating and air con-

(Continued on page 332)



A Man Nobody Wants

Close inspection will show that the entire horse is in this picture, after all. Our mounted subject's current project is necessarily long term: he is out to prove that Univac made a mistake in contradicting one of his pet hypotheses. (It took Univac four hours to come up with its answer.)

This equestrian is so pedestrian that he would never be interested in the fancy-stepping Rogers stable.

Anyway, Rogers is devoted to serving engineers – those men who range eagerly across the face of the globe seeking someone who will breed another winner, sired by imagination out of originality.

Like the big auto maker that needed a transmission gasket material that would work. Rogers developed one, without wasting oats. We invite engineers to send us their names and addresses, so we can send them some plugs that will spur their interest.

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DUROIDS—for Gaskets, Filters, Electronic Devices, Thermal Insulation, etc. **ELECTRICAL INSULATION**—for Motors, Transformers, Generators, etc.
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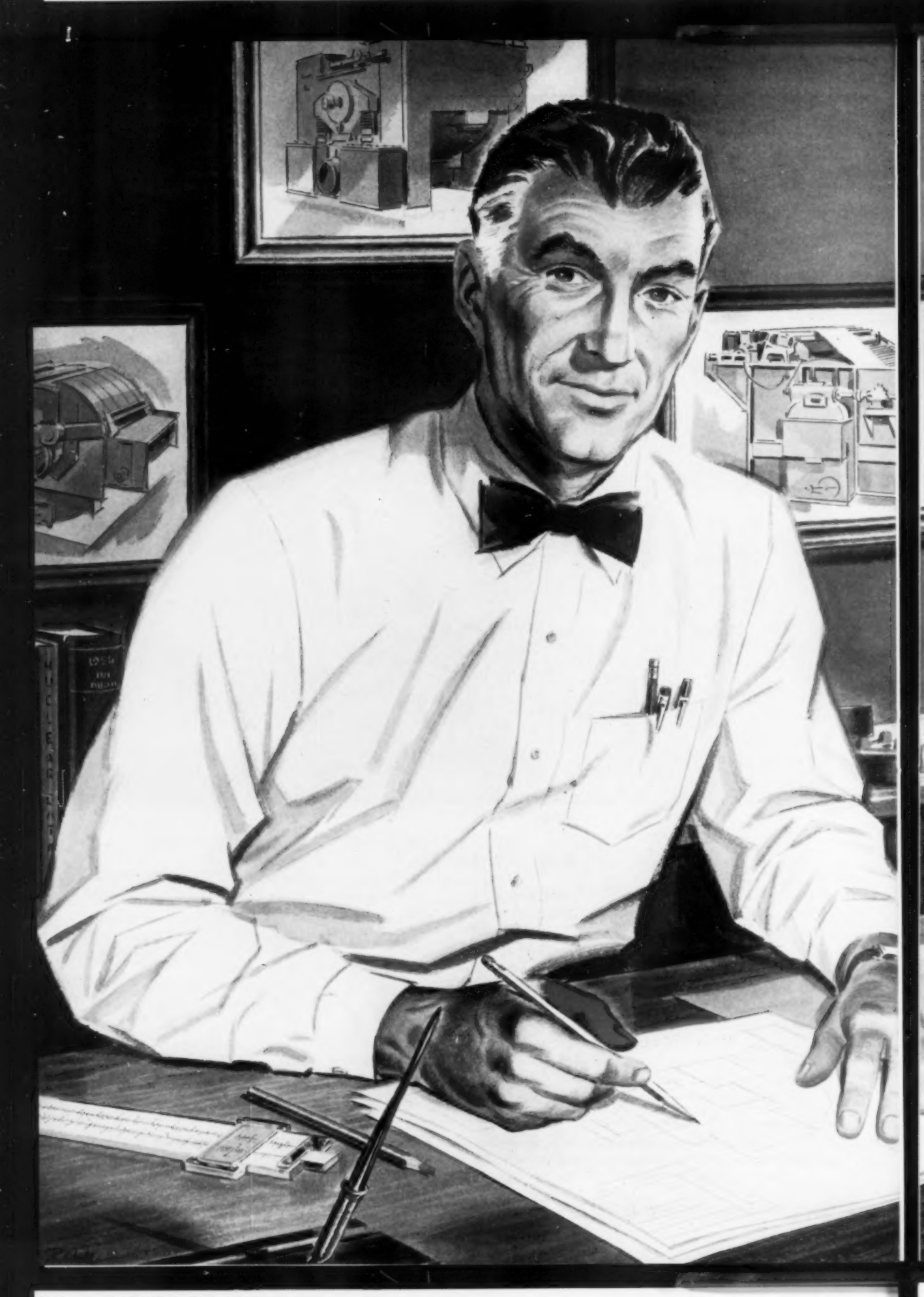


product-design engineers MAKE MARKETS GROW

The idea for a new product can start anywhere, but nothing happens until the design engineer is given the final responsibility to actually create it. Only then does the chain reaction take place that makes the Original Equipment Market the most dynamic, challenging and rewarding sales target in the world.

Like a lady buying red shoes, one basic design decision leads to another, and another, and another. Every new product, or improvement, opens the door to countless alternative design possibilities. Because the design engineer is responsible for the total performance of the finished product, he must study, evaluate, select, and integrate the latest developments in all fields of design engineering.

Decisions relating to electronics, hydraulics, pneumatics, fastening and joining, power transmission, etc. — they all stem from the test: "Will this design do it better? And if so, how does it affect the other design decisions?"

Materials, parts, finishes involve thousands more decisions. They meet the same test of objectivity: "Will this do it better?" After testing, even after marketing, many of these decisions will be changed. Always under pressure to get the design "frozen" for production, they must make decisions within given time limitation.

Sometimes design engineers make wrong decisions, but they know better than anyone else the high price of watching their "mistakes" come rushing off the production line. That's why they seek all the facts, and weigh carefully the pros and cons, of every single item that they specify. There are no unimportant decisions, for even the smallest, most insignificant unit can destroy total product performance.

The man with the green thumb is an apt title for the design engineer. For he is the man that makes markets grow. Look at any growth industry—aircraft, electronics, office equipment, machine tools, appliances, autos, etc.—and ask yourself how it got that way. Many people contributed original ideas, but nothing really happened until the design engineer harnessed the right design to the right materials, parts, finishes. These are the men who will keep markets growing by making us dissatisfied with last year's model, and by constantly tempting us with better, more efficient products.

They keep their magazine growing, too. In the past five years their subscriptions have doubled the circulation of PRODUCT ENGINEERING. No wonder advertisers put more pages, and invest more dollars, in Product Engineering than any other design publication.

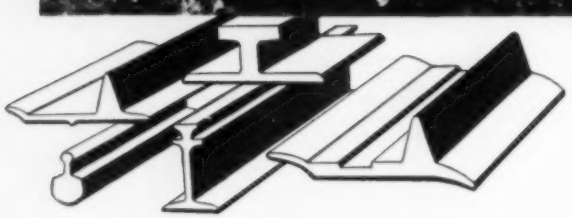
Product Engineering
MAKES SALES GROW

ABC ABP

The McGraw-Hill Magazine of Design Engineering

McGraw-Hill Bldg., New York 36, N.Y.

WEST VIRGINIA SPECIAL SECTIONS
in this
Caterpillar®
No. 933
Traxcavator



Resulted in great savings — maintained highest quality standards for the Caterpillar Tractor Company.

Specially engineered sections saved high planing and machining labor costs. West Virginia engineering consultants helped develop a special rolled section produced to the rigid, high specifications required for any Caterpillar-built machine.

West Virginia Special Sections have saved time and money and assured ultimate strength in the products of many major companies. A West Virginia engineer may be able to help you with your production problems.

For free Engineering Consultant Service, call or write West Virginia Works, Connors Steel Division, H. K. Porter Co., Inc. at Huntington, West Virginia.

HKP CONNORS STEEL DIVISION
H. K. PORTER COMPANY, INC.

ditioning equipment, stokers, oil and gas burners.

A control dial, scaled in 15 min graduations, is used to set up a daily operating schedule. Running periods are set by sliding self-contained, non-removable trip levers in or out on the dial. The switch will repeat the entire schedule automatically each day.

A calendar cutout device which will make the switch completely selective for all seven days of the week is available as an accessory. With this device, the switch makes provision for non-working days. The mechanism is powered by a heavy-duty, synchronous industrial motor, lubricated for life. Capacity is 1000 w, using 60 cps, a-c current. Action is single-pole, double-throw. Zenith Electric Co., Dept. PEN, 152 W. Walton St., Chicago 10, Ill.

For more information—
Circle 96, inside back cover

High-temperature Conductor Wire

Basically pure iron, coated with special aluminum and aluminum-iron alloy, this wire is said to have approximately six times the resistance of copper and increases in resistance about four times in 1000 F. Available in quantity in all standard sizes for temperatures up to 1500 F, in 20 ft lengths. Continental Wire Sales Co., Wallingford, Conn.

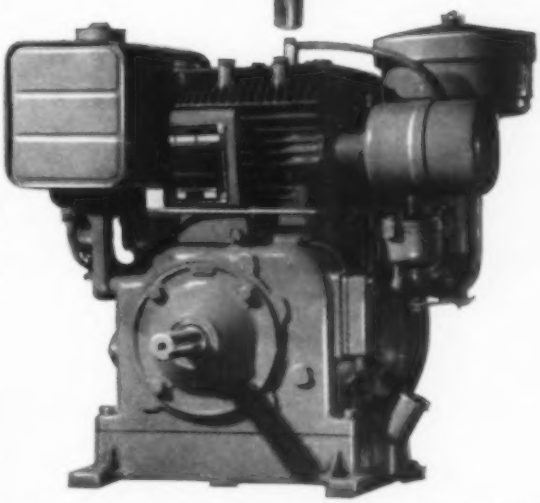
For more information—
Circle 97, inside back cover

Pressure Transducer

Designed to probe pressure changes in formerly inaccessible locations, this variable resistance-type pressure transducer adds less than 0.004 cu in. to the volume of the system under test.

(Continued on page 334)

Power partners that add to the prestige of your product!



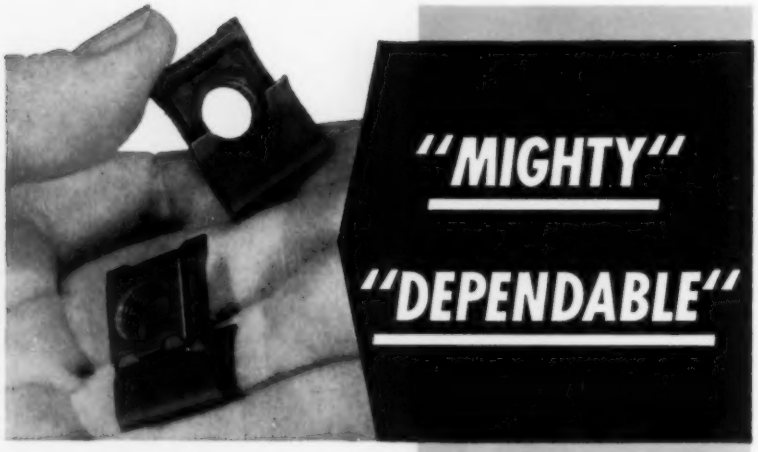
Why? Because Briggs & Stratton engines — *No. 1 in use throughout the world* — bring your products added user preference . . . added prestige and value from a sales and profits standpoint.

The vertical shaft 2.25-hp light weight engine and the new horizontal shaft 7-hp Model 19 at right — are two of many models up to 9 hp in the Briggs & Stratton line. You get a wide choice that means greater opportunity to find the correct power for your products.

And for assistance that may help reduce board time, utilize Briggs & Stratton's consulting engineering service. It's likely they already have the answers to some of the power application problems you're now facing. Remember too, wherever your product is used — authorized Briggs & Stratton service is nearby.

4 CYCLE
BRIGGS & STRATTON
GASOLINE ENGINES ®

BRIGGS & STRATTON CORPORATION
MILWAUKEE 1, WISCONSIN



PRESTOLE STAKE NUTS

- **EASE and SPEED OF ASSEMBLY**
- **GREATER STRENGTH and HOLDING POWER**

...used in high speed assembly of metal parts and panels

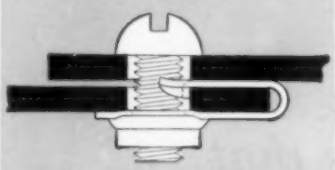
Looking for extra strength and more dependability in a fastener for metal panels and parts?

HERE'S THE ANSWER . . . the improved Prestole Stake Nut. Hundreds of fast assembly applications that are subjected to heavy service and vibration, such as automotive parts, are ideal for this Prestole engineered fastener.

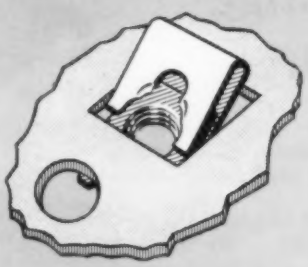
Hand applied—it quickly locks into bolt-receiving position over the panel hole, utilizing the formed catches on the lower leg of the clip. The unit is ideal for blind location attachments.

Prestole Stake Nuts are available in various multiple thread sizes and panel ranges, and in finishes to meet specifications.

1 EDGE FASTENING



2 CENTER PANEL ASSEMBLY



Creators of the famous Prestole impression "that lasts." Standard and special fasteners to meet specific requirements.

PRESTOLE Corporation
1321 MIAMI STREET, TOLEDO 5, OHIO

Please send engineering application data for the following specifications:

SCREW SIZE..... PANEL RANGE ± ..... HOLE LOCATION ± .....

Application.....

Name.....Title.....

Company.....

Street.....

City.....Zone.....State.....

TRY THEM FOR HEAVY-DUTY APPLICATIONS

It can be used with liquids and gases with excellent temperature stability from −65 F to 250 F and holds calibration under long exposure to severe pressure transients.

Full scale pressure ranges are available up to 5000 psi with full output signals greater than 0.1 v. The nominal size, exclusive of the 8-32 threaded hydraulic connection, is ½ x ¾ in. long. Standard Controls, Inc., 1130 Poplar Pl., Seattle 44, Wash.

For more information—
Circle 98, inside back cover

Environment-Resistant Electrical Connectors

These plugs and receptacles are said by the maker to be impervious to water, moisture, oil, gas, dust, pressure, vibration and shock. The connectors meet NEMA requirements for power, lighting, control and coaxial circuits. Pyle-National Co., 1334 N. Kostner Ave., Chicago 51, Ill.

For more information—
Circle 99, inside back cover

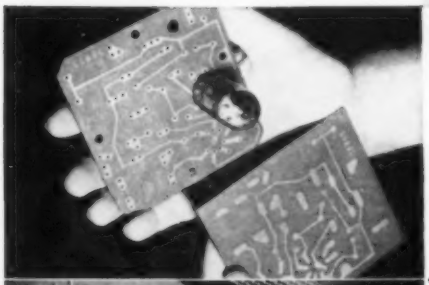
Electrical Conduit Bracket

Application is as follows: bracket is placed over conduit and required fittings are attached to conduit. Bracket is slipped back down over hubs on fittings and tightened with Allen wrench. Bracket is then secured to machinery through holes in wings.

(Continued on page 336)

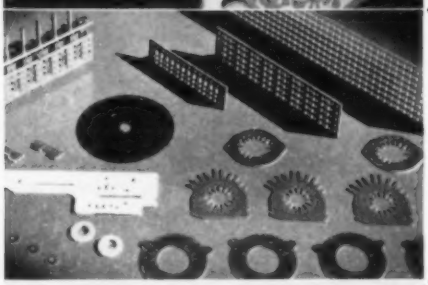
RICHARDSON – plastics for electronics

. . . laminated—molded



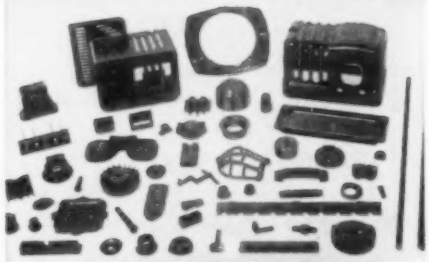
COPPER-CLAD INSUROK

Choice of various grades. Copper bonded to one or both sides. Outstanding electrical properties after humidity conditioning. High flexural and tensile strength. Holds metal inserts and lugs securely. Excellent bond strength and heat resistance.



FABRICATION

Complete facilities for punching or machining precision parts from laminated INSUROK to your specifications in any quantity—for electrical or mechanical applications.



MOLDED PLASTICS

Parts molded from standard or special plastics materials as required for your product, including newest plastics. Produced by compression transfer or injection processes. Metal inserts molded in position.

LAMINATED INSUROK

Available in sheets, rods, and tubes in NEMA and special grades. Properties to meet practically any electrical or mechanical requirements. Many sizes and thicknesses.

technical services

Experienced Richardson engineers will analyze your requirements and help you select the material, and best manufacturing process for your needs . . . and when your requirements are unusual, Richardson offers extensive background for developing special plastics materials for your product. Also, Richardson is equipped to provide complete facilities and techniques for molding, laminating, molded laminates, and fabricating. You are assured the correct material and process for each application. These research, design, and engineering services are yours without cost or obligation, of course. Write or phone, today.

Write for 12-page booklet
"INSUROK® Laminated Plastics—Molded Plastics"

The RICHARDSON COMPANY

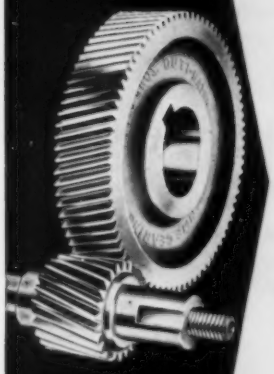
LAMINATED AND MOLDED PLASTICS

Dept. 16, 2793 Lake Street
Melrose Park, Ill.

PREMIUM GEARING
at Production-Run Prices

Foote Bros. Offers Engineered Helical and Worm Gear Sets FROM STOCK

1638 Duti-Rated COMBINATIONS



IN STOCK:

*Horsepower Ratings....1 to 200**
*Center Distances.....2" to 12"**

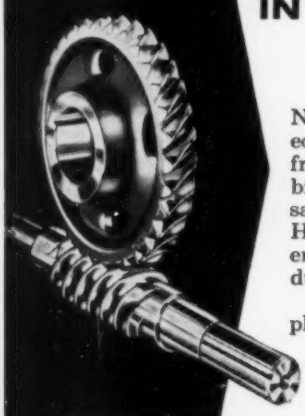
Check with Foote Bros. *before* you finalize that design. The chances are you'll find exactly what you need among the 1638 *stock* combinations of Duti-Rated Helical Gears.

When you buy Duti-Rated Gearing, you'll get more than best for your money . . . you'll get the benefit of thousands of engineering and development hours . . . and the unquestioned advantages of precision tooling and manufacturing methods. You'll get performance proven in countless Foote Bros. Line-O-Power and special drives, and Foote Bros. —Louis Allis Gearmotors. This is high hardness, accurate, balanced design gearing that will give you more load capacity and wear life per dollar.

**Larger sizes made to order from standard tooling.*

Write for DUTI-RATED catalog: Engineering Manual DR No. 2.

150 WORM GEAR COMBINATIONS



IN STOCK:

Horsepower Ratings....1 to 100†
Center Distances.....2" to 12"†

Need worm gear and worm sets? There is economy and convenience in choosing them from the many Foote Bros. worm gear combinations available from stock. This is the same gearing used in famous Foote Bros. HYGRADE Enclosed Worm Gear Drives . . . engineered, premium quality gearing at production-run prices.

Engineering Manual SW No. 1 has complete details. Write for your copy.

† Tooling available for larger worm gear sets, engineered, but not stocked, to 200 HP and 18" centers. Prompt deliveries.

ENGINEERING SERVICE

Let us help you select standard helical or worm gearing to meet your special requirements, or, let us design and build your complete unit. Place your gear problems in the hands of experienced power transmission and gear engineers. Your inquiry is invited, and there's no obligation.

FOOTE BROS. Duti-Rated LIFETIME GEARING

this trademark stands for the finest industrial gearing made

FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION
4545 South Western Boulevard, Chicago 9, Illinois

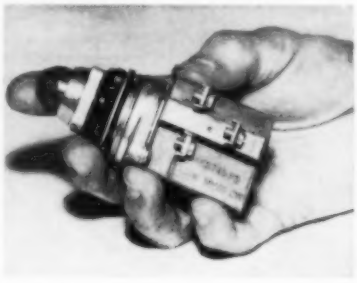
This eliminates the need for drilling and tapping holes in fittings for fastening. Ideal-Simplet Fittings, Inc., 1446 Park Ave., Sycamore, Ill.

For more information—
Circle 100, inside back cover

Subminiature Trimming Potentiometers

Trimming potentiometers with tabs for printed circuit applications are ½ in dia and weigh ¼ oz. Resistance rating is 10 ohm to 150 k. Power, 2 w at 60 C max. Temperature limits are −55 C to 125 C. Ace Electronics Associates, Inc., 103 Dover St., Somerville 44, Mass.

For more information—
Circle 101, inside back cover



Push-to-test Indicating Light

A push-to-test indicating light unit provides a quick and positive method of testing for burned out lamp bulbs on control panels and pushbutton stations. Through the use of a continuously energized testing circuit, an immediate indication of a faulty bulb is given by pressing the unit's color cap. It is not necessary to remove the indicating light cap or the bulb.

The device's basic unit is interchangeable with the company's new illuminated oiltight pushbutton by simple removal of jumper wiring. The

(Continued on page 338)

How you can save time and money with

Harvey Aluminum Impact Extrusions

Many engineers and designers are overlooking the exclusive advantages of aluminum impact extrusions. This advanced metalworking operation offers design flexibility; versatility of alloys; draft free, close tolerance parts requiring minimum machining; smooth surfaces; and significant savings in man hours, machining, and material.

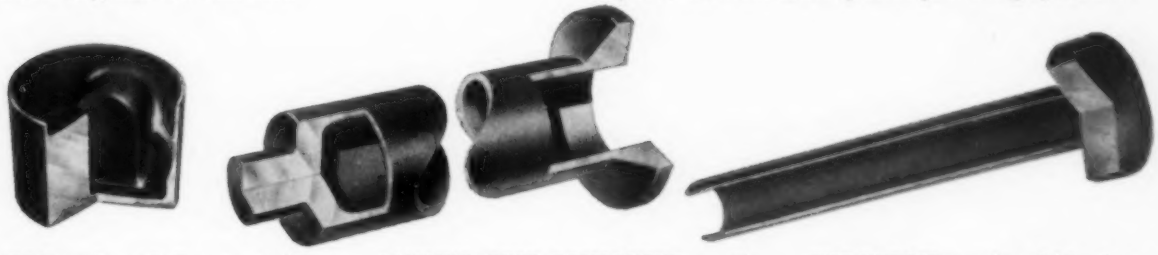
Custom configuration with precision tolerances

Typical applications of Harvey Impact Extrusions are illustrated below. Harvey Impacts have a smooth surface and require no machine finishing for most commercial, ordnance, airframe, and missile applications. Harvey's integrated services provide an economical, quality product that meets all specifications of high strength, light weight, resistance to corrosion and heat, critical tolerances in wall thickness, maximum heat conductivity, and low unit cost.

Harvey Aluminum leads in impact extrusions

Harvey pioneered in the impact extruding of intricate configurations. This experienced leadership, plus technical know-how and the most advanced facilities, are available for your own specialized design requirements. The integrated Harvey engineering team of research, design, metallurgy, and quality control will expedite your product from drawing board to finished product quickly, efficiently, economically.

If you have a design that calls for hollow, closed end sections... high strength... zero-degree walls and surfaces... unusual length to diameter ratios, integral ribs, fins, and bosses... close tolerances... with volume production, low unit cost... *your Harvey Field Engineer will be happy to show you how Harvey Impact Extrusions can help solve your design problems.*



PISTON made with flat top or dome. Applications for aluminum pistons range from light horsepower engines to automotive and aircraft motors. Highest physical properties, surpassing any forging or casting. Metallurgical characteristics of Harvey alloys insure highest fatigue strength, excellent grain structure, best heat dissipation.

LANDING GEAR COMPONENT provides highest physical properties, greatly reducing material and machining costs. The impact, obtainable in various lengths, is made from aluminum alloys which assure optimum internal grain structure. This impacted piston replaces costly method of hogging out bar stock or machining a forging. Diameters of barrel are held to close tolerance dimensions with superior surface finish.

TUBE SUPPORT provides solid head on one end of tube. This unique aluminum impact extrusion offers the most economical fabrication method for a support tube application without sacrificing high physical properties. Aluminum impact eliminates considerable machining, offers maximum design versatility. Available in a range of sizes and alloys.

Making the most of aluminum... for everyone

HARVEY ALUMINUM SALES INC., TORRANCE, CALIFORNIA

Branch offices in principal cities

HARVEY Aluminum

Harvey is a leading independent producer of quality aluminum products in all alloys and sizes: Rod and bar, pipe, tube, hollow sections, press forgings, forging stock, impact extrusions, structurals, special shapes, extrusions, screw machine products and other aluminum products. Harvey is also producing similar items in titanium and steel.

PIC *Endurance Rated* Counters
to Fit every need

Super-Wizard Electric Counters

200 Million Count Life.

The real heavy duty electric counter—unapproached leader for over 25 years.

5 watts power consumption.

Quiet, no AC hum.

Available for all standard voltages and frequencies including DC.

Silver King Stroke Counters

The Toughest Stroke Counters

200 Million Count Life

Used in automobile and aircraft plants, stamping, metal working, die casting and plastic molding plants, and factories of all kinds.

PIC-600 Electric Counters

QUIET no AC hum

50 Million Count Life

Tested at 1000 CPM; reliable at much higher speeds with suitable actuation.

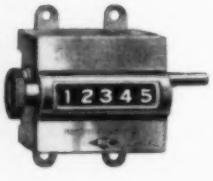
Only 7 watts power consumption.

Available for all standard voltages and frequencies including DC.

Silver King Revolution Counters

Rugged as a bull dozer.

Operate smooth as a watch.



200 Million Count Life

Used on measuring machines and coil winders, for revolution counting on engines, pumps, etc. and for tool registration.

Mercury Electric Counters

Small, compact counters for use where space is limited and duty is light to moderate.

Extensively used for laboratory service, also for built-in application on office machines, light industrial equipment, and vending machines of all kinds.

Knob Reset models rated 6 million counts, Non-Reset, 3 million.

Junior King Stroke Counters

Small, light to moderate duty mechanical stroke counters for use where space is limited and duty is light to moderate.

Widely used for laboratory service, also built-in application on office machines, light industrial equipment, etc.

Reset models have 6 million count life; non-reset models 3 million

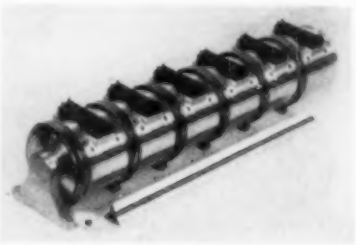
See your PIC Distributor or send for the PIC catalog describing Electric Counters and Actuators; Mechanical Stroke and Revolution Counters; and electrically operated Automatic Batch Counters.

PIC *Production Instruments*
DIVISION OF GENERAL CONTROLS CO.
702-10 West Jackson Boulevard, Chicago 6, Illinois
manufacturers of counting instruments for every purpose

42 Branch Offices and Representatives serving USA and Canada

cap is faceted for wide-angle visibility and is available in six colors: red, green, amber, white, blue, and clear. The device uses No. 12, 6-v bulb. The unit meets the newly revised JIC standards for push-to-test indicating lights. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 102, inside back cover



Phasable Multipole Stacking Switch

With this switch, it is possible to stack up to 20 poles in a single unit. The switch is comprised of sections held together by V-band clamps. The end of the shaft in one section fits integrally with the end of the shaft of the adjoining section, so no couplings are needed. Each section contains two contact plates. Each contact plate is phasable with every other plate by a screw adjustment. Plates may be made with from one to three poles, with up to 90 contacts per pole. Various types of drive motors are available providing switch speeds up to 600 rpm. Applied Science Corp. of Princeton, Princeton, N. J.

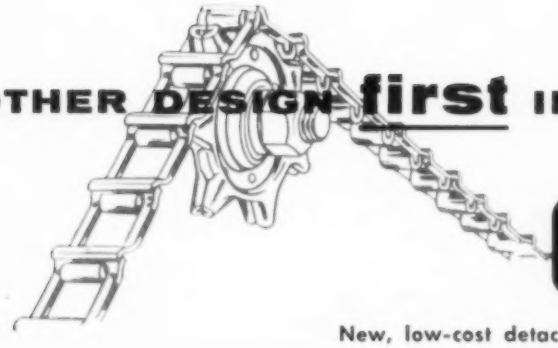
For more information—
Circle 103, inside back cover

Direct-Printed Circuits On Almost Any Shape or Material

These circuits may be applied to a base of almost any geometrical shape, including the inside or outside of tubes, the surfaces of flats, cylinders, spheres, cones. The choice of base material includes cellophane, cellulose acetate and butyrate, vinyl chloride and acetate, acrylics, styrenes, polyesters (including Mylar), nylon, CR39 resin, phenolics, epoxies, silicones, melamines, Kel-F, Teflon, mica, paper, wood, ceramics and glass.

(Continued on page 342)

ANOTHER DESIGN first IN SPROCKET IDLERS



by

Aetna

New, low-cost detachable link chain idler combines bearing, seals and sprocket wheel in a single, compact *package* unit to give you finer performance . . . longer life . . . greater economy . . . up to 66⅔ % saving in weight over solid cast steel idlers.

- Simple, weight-saving design. *Package* construction for easy, quick installation.
- Full complement of balls for greater capacity, 4-point ball contact for extra rigidity.
- Inner and outer bearing races case hardened for high fatigue and shock load resistance.
- Heavy gauge, case hardened steel teeth provide full contact-support area for chain cross bars.
- Large factory-packed lubricant chamber eliminates all need for relubricating.
- One-piece Buna-N rubber seals provide self-contouring positive contact; are corrosion and rust-free and exceptionally effective in excluding contaminants and retaining lubricant.
- Also available with teeth to fit standard or extended pitch roller chain.

This new detachable link chain idler is the latest addition to Aetna's growing line of sealed, pre-lubricated ball bearing *package* units which bring low-cost, anti-friction efficiency within the range of all light-duty moderate-speed equipment. All are quality built for top performance and dependability without maintenance of any kind. Write for complete data on the full line. Aetna Ball & Roller Bearing Company, Division of Parkersburg-Aetna Corporation, 4600 Schubert Avenue, Chicago 39, Illinois.

OTHER AETNA *Package* UNITS

Aetna

ANTI-FRICTION CONSULTANT TO LEADING ORIGINAL EQUIPMENT MANUFACTURERS SINCE 1916

New stop clock designed for accuracy, versatility

Today's product designer, control systems engineer, nuclear physicist, and graphic panel manufacturer have a common need—an instrument capable of measuring elapsed time to a hundredth of a second, with an accuracy better than 0.02 of 1%.

Wide field—wide requirements

But there the sameness ends—the nuclear physicist needs a hermetically sealed device for remote control; the product designer requires load switches and local pushbutton reset; the graphic panel man wants smart appearance. The lab technician wants a portable model. The military asks for the smallest unit consistent with reliable readings, while the sports event timekeeper must have a large dial.

How can you meet these diverse requirements? Well, here's the answer to that question—a product of Cramer's experience and knowledge of precision timing.

Accuracy for everybody

You select a small, powerful and inherently accurate drive motor, add a 110-tooth positive clutch and apply it on the high-speed shaft. Back it up with a potent relay. When the signal comes, the unit responds instantly, and we have *accuracy*.

All-electric operation for flexibility

Add heart cams on the mainshaft and a rugged solenoid to belt them home within 1/10 second after the reset switch is operated. Now we have *electrical reset*, either remote or local.

For *versatility*, provide for load switches with cams on fast or slow pointer shafts. Cut and set at the factory, cams will offer a variable number (and duration) of pulses per second or minute, or with load switches wired in series, the unit can be used as a highly precise time delay relay or interval timer.

Commercial or Mil-Spec housings

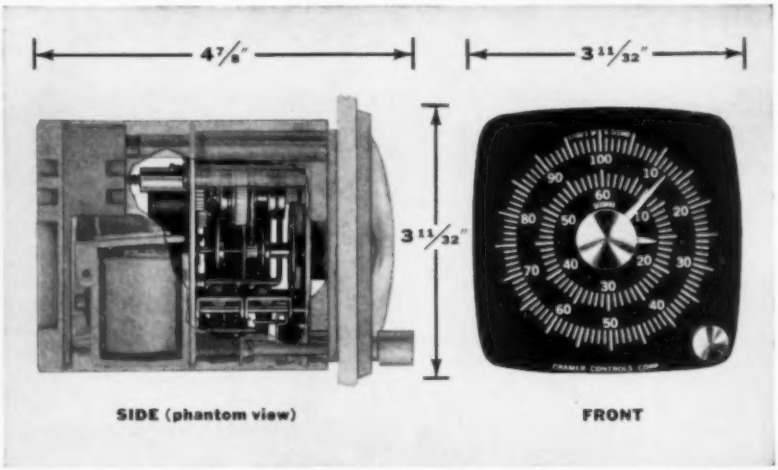
Now let's enclose the mechanism. Commercial housing is dust-tight and has a 12-place terminal block. Also developed: a militarized model to withstand high vibration, shock and severe environments. A deep-drawn solder-sealed enclosure with 14-pin glass-beaded header, evacuated and hermetically sealed will do it.

Dials, pointers—Loewy styled

What's left? The business end of things—dial and pointers. Let's tackle this for readability, and at the same time, shoot for eye-appeal. This time we'll go to the *styling* experts — famous industrial designers, Raymond Loewy Associates. They come up with the last word in human-engineered dial-pointer combination for fast, exact readings. Frame it with a pleasing bezel that can be finished to match or harmonize with your panels.

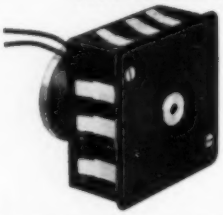
Now it looks like the precise instrument that it is—the new Cramer Type 691 Time Totalizer. Bulletin PB-691 tells more about it. Write for your copy today. The Cramer Controls Corp., Box 7, Centerbrook, Conn.

P.S. We've got the six-inch dial version and the portable model, too. 7.20

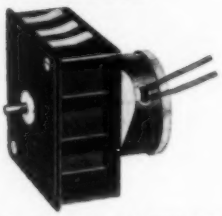


NEW time totalizer. Type 691 features instantaneous electrical reset, accuracy within 0.02 of 1%. Standard ranges: 60 seconds in 1/100 sec., 60 minutes in 1/100 min., and 60 minutes in seconds. Factory-set cam-operated load switches (rated at 5A, 250 vac, resistive) can be supplied. Available for standard voltages at 50, 60 cps; for 400 cps with d-c clutch; and for d-c voltages. Mechanical and electrical life in excess of 1-million operations.

TWO MORE NEW CRAMER PRODUCTS



NEW cycling timer. Type 571, ideal for "cycling" electrical equipment such as appliances, vending machines, advertising displays, at lowest possible cost. 1 to 4 poles. Speeds from 1 rpm to 1 revolution in 8 days with 30-amp contacts. Faster speeds with lighter contacts on special order.

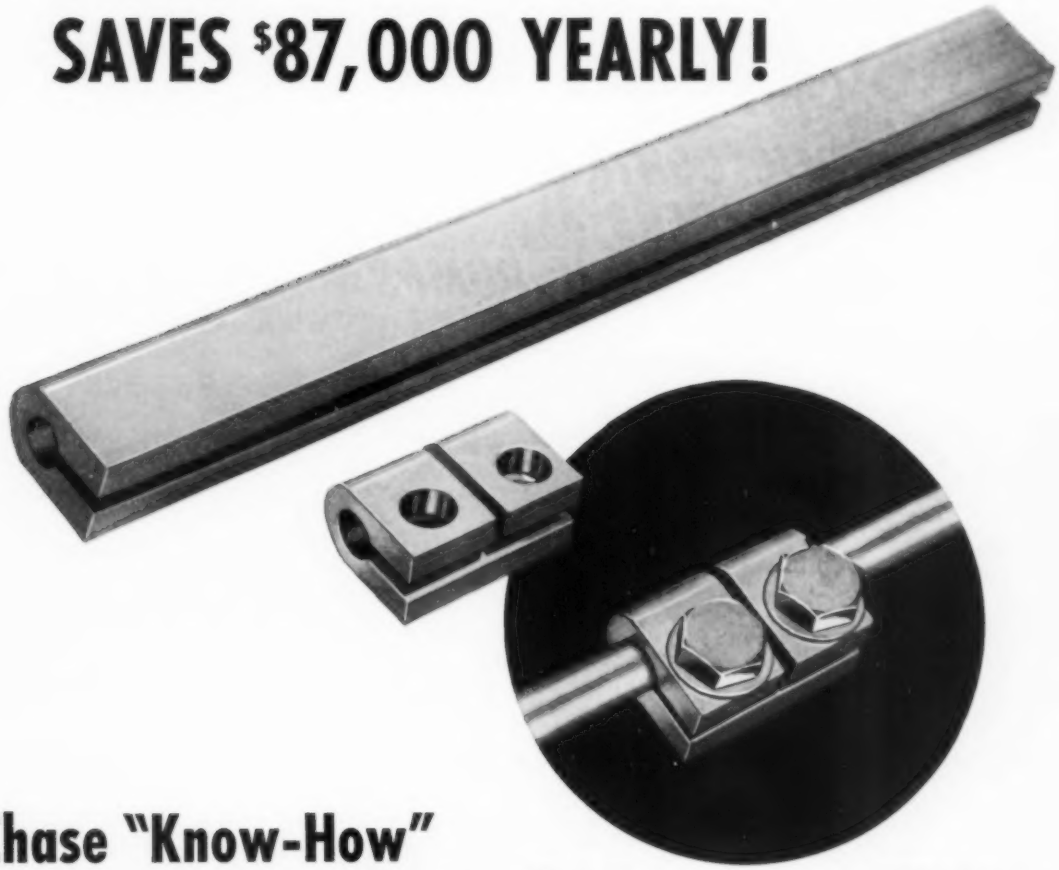


NEW interval timer. Type 271, for built-in applications. Provides an economical way of timing appliances, photo equipment, ovens, etc., for manually preset interval. 1 or 2 poles. Time ranges from 45 seconds to 6 days with 30-amp contacts. Normally furnished without knob or dial.

TALK IT OVER WITH

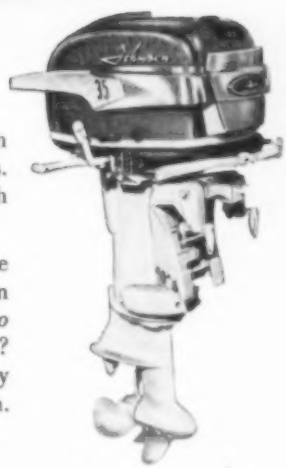
CRAMER CONTROLS
CORPORATION

"IMPOSSIBLE" BRASS EXTRUSION SAVES $87,000 YEARLY!



Chase "Know-How" cuts costs for Johnson Motors

(world's largest manufacturer of outboard motors)



The shift-rod connector on rugged, dependable Johnson Sea-horses had to be strong enough to hold up under severe stress and compact enough to operate in the clearances available on smallest engine models.

Stamped parts were completely unsatisfactory. Parts machined from rod were too bulky for versatile applications. So they checked with Chase to find out how closely a brass extrusion could approximate their requirements. And Chase "know-how" came through beyond their expectations!

Chase mill techniques proved to be so precise that the required extrusion *needed no additional machining to cross-sectional dimensions!* Result? An annual saving of approximately $87,000 *plus* a much better design.

Bring your production problems to . . . Chase®

BRASS & COPPER CO.

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SUBSIDIARY OF KENNECOTT COPPER CORPORATION

The Nation's Headquarters for Brass, Copper and Stainless Steel

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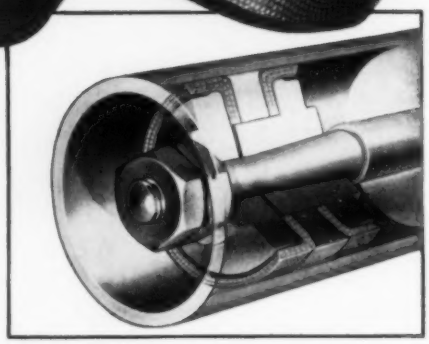
PUMCUP ADVANTAGES

now yours for

- **HYDRAULIC CONTROLS**
- **AIR CYLINDERS**
- **RECIPROCATING PUMPS**

Two common Pumcup types: conventional and 45° bevel type . . . available in a complete range of sizes and texture-engineered compositions.



Cutaway view of typical Pumcup installation resulting in prolonged high efficiency.

TAKE it from experienced users, Darcova Pumcups offer payoff advantages that can't be equalled! For example, they last many times as long as ordinary piston packing..and they *hold peak efficiency* from start to finish. Because of the resulting production and maintenance economies, plant after plant is standardizing on Pumcups.

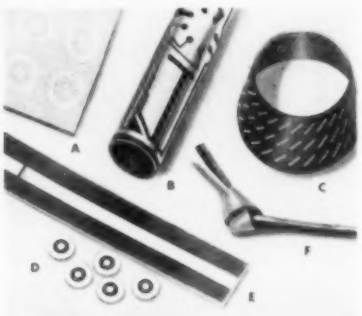
Improved application of the cup principle does the trick. And Darcova Pumcups are *texture-engineered* in *a range of compositions* to meet most temperature-pressure-fluid conditions. And they are available in sizes and types exactly right for your particular equipment.

It will pay you to get *all* the facts. Just ask for Pumcup Bulletin No. 5503.

DARLING VALVE & MANUFACTURING CO.
Williamsport 25, Pa.

DARCOVA
THE ORIGINAL COMPOSITION CUP

TRADE MARK
PUMCUPS



High adhesive qualities are obtained, with any base material, through variations in ink formulations. Lines as narrow as 0.005 in., ± 0.001 in. can be printed and the depth of deposit is closely controlled. Some formulations permit dip or iron soldering.

These circuits have been successfully used on rotors, stators, commutators, wave guides, capacitors, resistance heaters, antennae, in computing and telemetering equipment. J. Frank Motson Co., Flourtown, Pa.

For more information—
Circle 104, inside back cover

Differential Switch for Vacuum and Low Pressure

This switch 2273 has a metal diaphragm and comes in two classes, for sensing pressure differences from 15 in. water below atmospheric pressure to 80 in. water above. The fixed actuation value ranges from 0.2 in. water to 2 in. of water, depending on the switch setting.

The reference pressure must be air or an inert gas; the variable pressure may be liquid or gas. The switch will actuate an electric circuit on an increase or decrease of a predetermined pressure difference. It can be adjusted by an external adjustment screw for field setting. This external adjustment is tamperproof.

The switch is not sensitive to jar-

(Continued on page 344)

"To Grease or not to Grease!"...

THAT IS *not* THE QUESTION WITH Lubriflush*

***U.S. MOTORS self-lubricated for normal life plus Lubriflush for extra life!**

MOTOR LIFE IS INCREASED WITH Lubriflush

Bearing failure, in most cases, is due to inadequate lubrication rather than inability to carry the load. With the exclusive Lubriflush system, U.S. motors give you extra advantages—convenient, thorough *transverse* re-lubrication. No longer is it necessary to tear down your motor to get at the bearings to do a re-greasing. Lubriflush directs transmission of new grease *transversely* from behind the bearing, through the ball race to the opposite side, expelling the old worn-out grease through the drain. In ordinary bearings, the new grease replenishes only one side of the bearing, failing to effect a complete re-greasing.

Free!

Get this 8-page full color booklet on Motor Lubrication

A real refresher course on motor lubrication. Tells all about motor bearing greasing. Fact-packed pages reveal engineering data that will amaze you. Send Coupon.

U.S. Electrical MOTORS

MAIL COUPON NOW

U. S. ELECTRICAL MOTORS Inc. PEN-6
Box 2058, Los Angeles 54, Calif. or Milford, Conn.

☐ *Send Lubriflush Booklet* ☐ *Send General Booklet*

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STRETCH ROLLS THAT STRETCH DOLLARS... for manufacturers of paper-making machinery. They're centrifugally cast by Shenango to provide complete uniformity, pressure-dense grain, freedom from blow holes, sand inclusions and other hidden defects. They'll wear longer, take abnormal stresses, loads and speeds without the risk of costly failure. If you need virtually any symmetrical part, ferrous or non-ferrous, large or small, rough or finished, write to: Centrifugally Cast Products Division, The Shenango Furnace Company, Dover, Ohio.

SHENANGO CENTRIFUGAL CASTINGS

COPPER, TIN, LEAD, ZINC BRONZES • ALUMINUM AND MANGANESE BRONZES
MONEL METAL • NI-RESIST • MEEHANITE METAL • ALLOY IRONS

ring or vibration and it will operate in any position—no leveling or special mounting is necessary. The unit incorporates a UL-approved, single-pole, double-throw snap-action switching element rated for a-c and d-c. Recommended to operated relays, solenoids, motor controls and similar devices. Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.

For more information—
Circle 105, inside back cover

Dual Switch Pressure Control

This control contains two completely separate switches that operate independently, for controlling two separate circuits. Seven models provide a variety of adjustable ranges between 0 and 250 psi limits, and maximum pressures up to 350 psi. On-off switch differentials between the limits of 5 to 10 psi, dependent on model, are obtainable.

Pressure settings are individually made by independent adjustment screws located on top of the switch bracket.

The device is available in any one of three standard types: normally open, normally closed, or double throw with no neutral position. Switches are rated for 15 amp at 115 or 230 v a-c. Also available are d-c and 20 amp a-c switches. The switch is wired to screw-type terminals on the switches. The bellows material is either brass or Monel. United Electric Controls Co., 79 School St., Watertown, Mass.

For more information—
Circle 106, inside back cover

FLUID POWER, CONTROL

Pressure Regulator with Interchangeable Discs

Because the valve discs are now interchangeable, this valve is said to be easily switched from water service, for example, to steam, gas or air. Spring adjustment is made from below rather than from above as in previous models.

Reduced pressure range is from 1 to 100 psi, depending on the size of the

(Continued on page 346)

CITY ZONE STATE

VICKERS® HYDRAULICS

MINIATURIZED PISTON TYPE PUMPS are made in four size series. Unit shown packs 4.3 hp in 0.9 lb.
PACKAGED HYDRAULIC SYSTEM means complete compatability of components and the responsibility for design, manufacture and performance testing by a single responsible source. Output is approx. 2.5 equiv. hp; length approx. 14"; weight approx. 13.5 lb.
PACKAGED HYDRAULIC SYSTEM provides small envelope, reduced weight, minimum piping, and "plug-in" construction for easy installation and servicing. Output is approx. 2.5 hp; length approx. 13½"; weight approx. 19.5 lb. (including power source).
ELECTRICAL POWER PACKAGE uses hydraulic system to provide closely regulated 400 cycle, AC power with minimum weight and envelope. 1 kva package shown weighs only 10.5 lb.

for Guided Missiles

As the rapidly-expanding missile program progresses, more and more applications are being found where Vickers Hydraulics will be used to advantage. Vickers has miniaturized components that can be integrated into system packages with minimum tubing . . . manifolding components gives no opportunity for leakage. These "packaged" systems with their optimum performance and *reliability* are used to power missile control surfaces. Minimum space and weight, easy installation and servicing are other important advantages. Get in touch with the nearest office listed at the right for further information.

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3201 Lomita Blvd.
P.O. Box 2003
Torrance, California

District Sales and Service Offices:
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Write for new Bulletin A-5216

7645

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

Best low-cost way to incorporate variable-speed into machine designs

Choose from 8 sizes . . . ¼ to 15 hp . . . 1.75:1 to 4:1 speed ratio. Converts any standard constant-speed motor into variable speed drive.
MAXIMUM TO MINIMUM OUTPUT SPEED POSITIONS

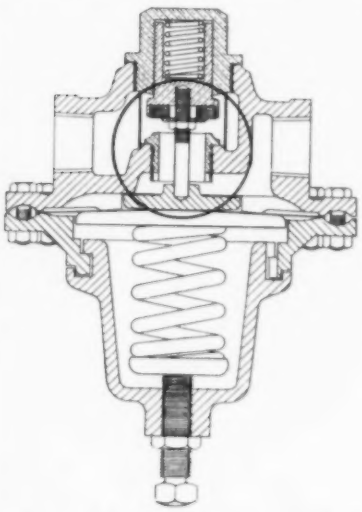
REEVES®

Vari-Speed Motor Pulley

Specify this easy, economical way to efficient and versatile use of the machines you design. REEVES-equipped machines adjust immediately to a variety of production speeds, production processes . . . you substantially reduce design and capacity obsolescence.

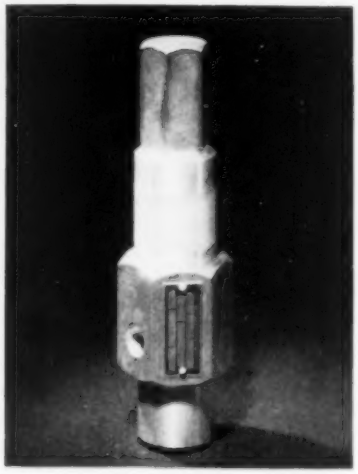
Your REEVES representative will be glad to work with you on the application best suited to your design. Offices in principal cities—or write direct for Catalog K28D-V545.

REEVES PULLEY COMPANY
Division of RELIANCE ELECTRIC AND ENGINEERING CO.
Columbus, Indiana



valve, with initial pressures as high as 400 psi. A built-in strainer is provided. This valve is made in bronze, semi-steel or steel body with special alloy trim available. Standard sizes are ⅜, ½, ¾, 1, 1¼ and 2 in. Davis Regulator Co. 2522 S. Washtenau, Chicago 8, Ill.

For more information—
Circle 107, inside back cover



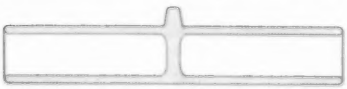
Hydraulic Safety Relief Valve

A hydraulic relief valve designed to have full capacity at 25% over-pressure has an inner valve assembly that can be replaced without special tools, without removing the valve from the line and without changing the original set pressure more than 5%. Inner valve parts are stainless steel. Two O-rings make the assembly back-pressure

(Continued on page 350)

THE CAMERON CURE FOR DESIGN DILEMMA

How would you produce this relatively simple component? Actually, it's not simple but Cameron had the cure. This actuator for the horizontal stabilizer of the North American F-100 Super Sabre is a cylinder with a thin solid center section and one central protrusion. For-



merly it was a weldment – two sections of tube stock with a small forging in the center – right here is where the headache developed because a cold bending operation was required. Welds parted, rejects were too high. The Cameron split-die forging process changed all of this.

Now it is forged in one piece. Grain structure is excellent, final machining and cold bending are easy–rejects are low and design department spirits are up.

If you have a problem in a ferrous component (200 to 5000 lbs.), especially one for critical service, with internal curvatures and perhaps odd protrusions which cannot be forged in conventional dies, CALL ON CAMERON.

Our facilities are complete from melting of high quality alloy steels for our unique forging operations to final machining if desired. Many knotty design problems are finding a simple solution in the unusual shapes and quality controlled alloys coming from Cameron. Write or call . . .

Cameron

IRON WORKS, Inc.

SPECIAL PRODUCTS DEPARTMENT

P. O. Box 1212, Houston, Texas

Fastener Facts

DESIGN PRODUCTION & PURCHASING DATA

by Henry Peterson, Chief Engineer — Judson L. Thomson Mfg. Co.

SHOULDERED RIVETS vs MACHINED PARTS

Both Act as Pivots!

When design calls for fasteners that also function as pivots for moving parts, it pays to consider shouldered rivets first. They may look much like screw machine parts that offer similar shoulder and tenon combinations; but the similarity ends there.

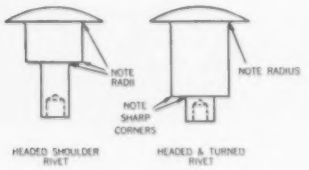
Rivets Cost Less!

Shouldered rivets cost only about half what you pay for their fully machined equivalents. That's because they can be cold-forged from solid wire in a single, high-speed operation. In most cases, no metal is removed, as with screw machine parts. So, you get all the stock you pay for.

Rivets Speed up Assembly!

Shouldered rivets are located and clinched by high-speed rivet-setting machines. Like semi-tubular rivets, they have shallow punched or drilled holes in their shanks to combine the shear and compression strength of solid rivets with low-cost fastening. On the other hand, comparable screw machine parts often require slow, costly hand locating and fastening.

Therefore, the savings in material and labor costs inherent in shouldered rivets demand their early consideration in cost reduction or value analysis programs. These low-cost, high-speed fasteners should be thoroughly investigated before designs are frozen in favor of more expensive screw machine parts.



Thomson Shouldered Rivets

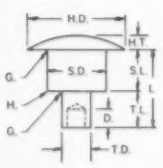
Thomson designs and produces shouldered rivets to specifications in two forms; completely cold-headed or cold-headed and turned, depending on permissible radius of corners and break of edges.

When close tolerances are not a factor as in folding baby carriages, car beds and seats, rollaway beds and comparable pivot-fastener applications, Thomson shouldered rivets are completely cold-headed . . . and, of course, priced at a minimum.

Where tighter fits are necessary, a secondary turning operation supplements the initial cold-forming to

square corners and edges to specified tolerances. Metal removal, of course is slight. As a result, these Thomson shouldered rivets cost slightly more than completely headed rivets, but much less then fully-turned parts.

Variables to Consider



In addition to permissible radius of corners (H) and break of edges (G), there are nine other design factors: head shape, the diameter (HD) and thickness (HT); shoulder diameter (SD) and length (SL); tenon diameter (TD) and length (TL); rivet length under head (L) and hole depth (D). Head shapes may be round, oval, flat, countersunk, or some special design. Because of all these variables, Thomson Shouldered Rivets are made to order after individual quotations.

Other Design Factors

It pays to think twice before you rule out shouldered rivets because of design and production consideration that seem to prevent insertion of rivet-setting machine's driver or anvil for clinching the rivets. In many cases, a slight change in spacing or cavity size allows use of rivets without changing overall dimensions. In other cases, a change in assembly sequence permits a profitable switch from costly hand assembly of expensive screw machine parts to low-cost machine-set rivets. Our engineering department, experienced in shouldered rivet applications, will be glad to offer suggestions while your designs are still in the rough-draft stage—at little or no cost.

Materials and Finishes

Thomson Shouldered Rivets are produced from aluminum, brass, copper, nickel-silver, low-carbon steel, stainless steel and other materials. They can be plated with brass, cadmium, copper, nickel, tin, zinc, etc. They can also be oxidized or finished in japanned colors to match the original equipment or end product.

Thomson High-Speed Machines

The inherent economy of shouldered rivets as pivot-fasteners is multiplied by high-speed assembly made possible by automatic rivet-setting machines which can be operated by unskilled labor. Thomson, inventor of the first automatic-feed rivet-setting machine, has developed more than 250 styles which can do thousands of fastening jobs . . . with or without adaptations. Multiple rivet-setting heads, special work handling and loading fixtures are optional features that further accelerate assembly operations. Thomson will select and custom tool the proper machines to speed assembly and reduce costs in your plant. You can either buy or lease them and Thomson's sales-service engineers are available to keep them in top operating conditions.

TYPICAL RIVET-SETTING MACHINES

FLOOR-TYPE FOOT-OPERATED

FLOOR-TYPE MOTOR-OPERATED

Design and Engineering Service

Contacted while designs can still be modified, we will analyze your pivot-fastening problems and tell you whether shouldered rivets are best for you . . . at little or no cost. Send sketches or prints, if samples are not available.

Free "Fastener Fact File"

(Soon to be released)

Be one of the first to profit from our new manual on all phases of riveting. It covers rivet types, applications, materials, finishes and other factors that determine selection of the right rivet design and machine for cutting fastening costs. Reserve your copy today. Write: Judson L. Thomson, Mfg. Co. Dept C, Waltham 54, Mass.

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the smooth, steady, unbroken
power flow of the jet take-off
throughout the entire 5.5/1 to 1/1 torque ratio range . . .

now offered for the first time by the revolutionary NEW Spicer 183 fully automatic converter transmission

This is really NEW . . . really REVOLUTIONARY . . . a fully-automatic converter transmission with direct drive or lock-out range, and *absolutely no interruption in the power flow to the rear axle!*

The acceleration period from rest is controlled entirely through the converter with ultimate smoothness without the aid of any gearing. As the converter approaches a 1 to 1 torque ratio a full power shift is automatically made without breaking the flow of power. This shift is accomplished by a hydraulically operated multiple disc clutch. After the shift the power flows directly from the engine crankshaft to the propeller shaft, bypassing the converter section entirely, resulting in (for all practical purposes) a 100 percent efficient unit.

On the highway . . . off the highway . . . this means smoother operation . . . reduced shock loads . . . greater operating and maintenance economy . . . less driver fatigue. He is merely required to manipulate the throttle and brake pedals.

No manual shifting required at any time except when selecting neutral or reverse!

Ask Dana engineers to help adapt the new Spicer 183 Converter Transmission to your heavy-duty needs.

DANA CORPORATION • Toledo 1, Ohio

DANA PRODUCTS Serve Many Fields

AUTOMOTIVE: Transmissions, Universal Joints, Propeller Shafts, Axles, Powr-Lok Differentials, Torque Converters, Gear Boxes, Power Take-Offs, Power Take-Off Joints, Clutches, Frames, Forgings, Stampings

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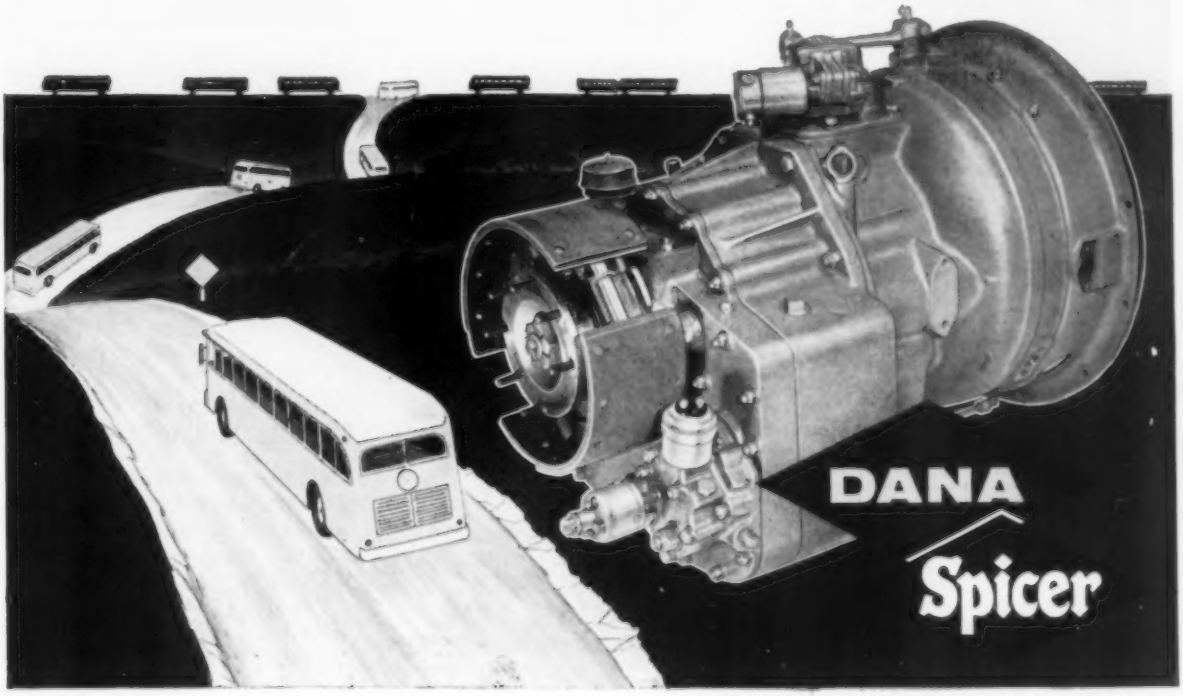
AGRICULTURE: Universal Joints, Propeller Shafts, Axles, Power Take-Offs, Power Take-Off Joints, Clutches, Forgings, Stampings

MARINE: Universal Joints, Propeller Shafts, Gear Boxes

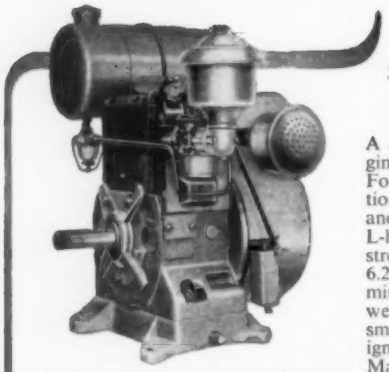
MANY OF THESE PRODUCTS ARE MANUFACTURED IN CANADA BY HAYES STEEL PRODUCTS LIMITED, MERRITTON, ONTARIO



I&L hot extruded, cold drawn

Step up performance of your power equipment...with one of these

3 New Onan Engines



MODEL AJ

Single-cylinder, gasoline-powered

5.5 H.P.

A compact, rugged, high-performance engine developing 5.5 H.P. at 3600 R.P.M. For heavier-duty applications on construction machinery, farm and garden equipment and similar products. Four-cycle; air-cooled; L-head; vertical cylinder; 2¾" bore; 2½" stroke; 14.9 cubic inch piston displacement; 6.25:1 compression ratio. Removable aluminum alloy cylinder head; fully counterweighted and balanced crankshaft for smooth operation. High tension magneto ignition. Mounted fuel tank and muffler. Manual pull-rope starting (recoil starter optional).

Overall dimensions: *Length (incl. shaft) 15⅛", height (with tank) 20", Width 20¼".* **Weight:** *(Dry with accessories) 86 pounds.* **Power take-off:** *Crankshaft extension 3⅛" long, 1" diameter.*

MODEL CCK

Two-cylinder, gasoline-powered

12.9 H.P.

Horizontal, two-cylinder opposed design gives this engine exceptionally smooth, quiet operation. Develops 12.9 H.P. with accessories at 2700 R.P.M. Pressure air-cooled; 4-cycle; 3¼" bore; 3" stroke; 50 cubic-inch piston displacement; 5.5:1 compression ratio. Extra-large bearing surfaces; high tension magneto ignition; governor regulation within 5%. Short, extra heavy crankshaft. Removable aluminum cylinder heads. Full pressure lubrication. Manual pull-rope starting. (Recoil starter optional).

Overall dimensions: *Length (incl. shaft) 14¾", Width 19½"; Height 17⅞".* **Weight:** *(Dry, with std. accessories) 148 pounds.* **Power take-off:** *Crankshaft extension, 2 13/16" long, 1½" diameter.*

MODEL DRP

Two-cylinder, air-cooled Diesel

15 H.P.

Where heavy duty performance, economy and safety are important factors, this air-cooled full Diesel engine has outstanding advantages. Electric starting; horizontal, 2-cylinder opposed design; develops 15 H.P. with accessories at 2300 R.P.M.; 4-cycle; 3½" bore; 3½" stroke; 67.3 cubic inch piston displacement; 17.3:1 compression ratio; forged steel crankshaft and connecting rods; extra-large bearing surfaces; full pressure lubrication; 12-volt generator.

Overall dimensions: *Length (incl. shaft) 26⅛", Height 28", Width 30¼".* **Weight:** *(Dry, with accessories) 516 pounds.* **Power take-off:** *Flywheel for disc drive; accessory crankshaft extension 4" long by 1½" diameter.*

Write for complete specifications

D. W. ONAN & SONS INC.

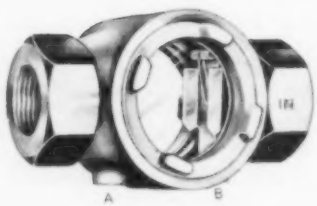
Onan ELECTRIC PLANTS

3825 University Ave. S.E., Minneapolis 14, Minnesota

tight. Another O-ring and two stress-relieving grooves prevent distortion of the nozzle, which oils leaktight operation.

The valve is available in aluminum up to 3500 psi and carbon steel and stainless steel up to 10,000 psi. Other alloys, as well as chrome plating, are also available. Made in sizes ¼, ⅜ and ½ in., inlets and outlets. Weight of the valve in aluminum is 2 lb and in steel 4 lb. Fluid Mechanics Co., P. O. Box 194, Bellaire, Tex.

For more information—
Circle 108, inside back cover



Sight Flow Fitting

These fittings are used to indicate the flow of liquid in a pipe line. They may be installed horizontally, vertically, diagonally or upside down. This unit has a spring-compensated, hinged indicator gate, which moves in proportion to the flow and is visible from either side of the fitting, even when the liquid is dark or discolored. Windows are easily removed for cleaning.

The fittings are available in sizes ⅜ to 6 in., inclusive, in brass, cast iron or steel, flanged or tapped. The device can be supplied with electrical contacts to operate a bell or light if the liquid flow should stop. W. W. Nugent & Co., Inc., Skokie, Ill.

For more information—
Circle 109, inside back cover

Tube Fitting For Flexible Tubing

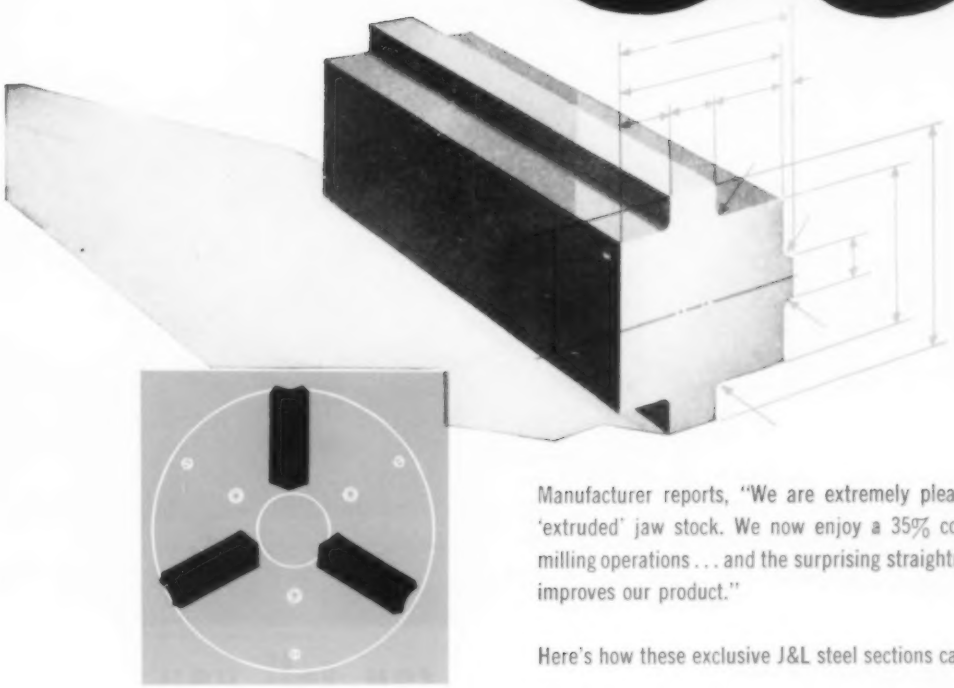
A fitting for installation in all types of flexible tubing requires no welding, adhesives or threading. This design does not reduce inside diameter or flow.

The fitting (elbow, tee, 90° or special design) is slipped on tube. Using a special ring holder, a ring is inserted

(Continued on page 355)

J&L hot extruded, cold drawn chuck jaw section reduced milling cost

35%



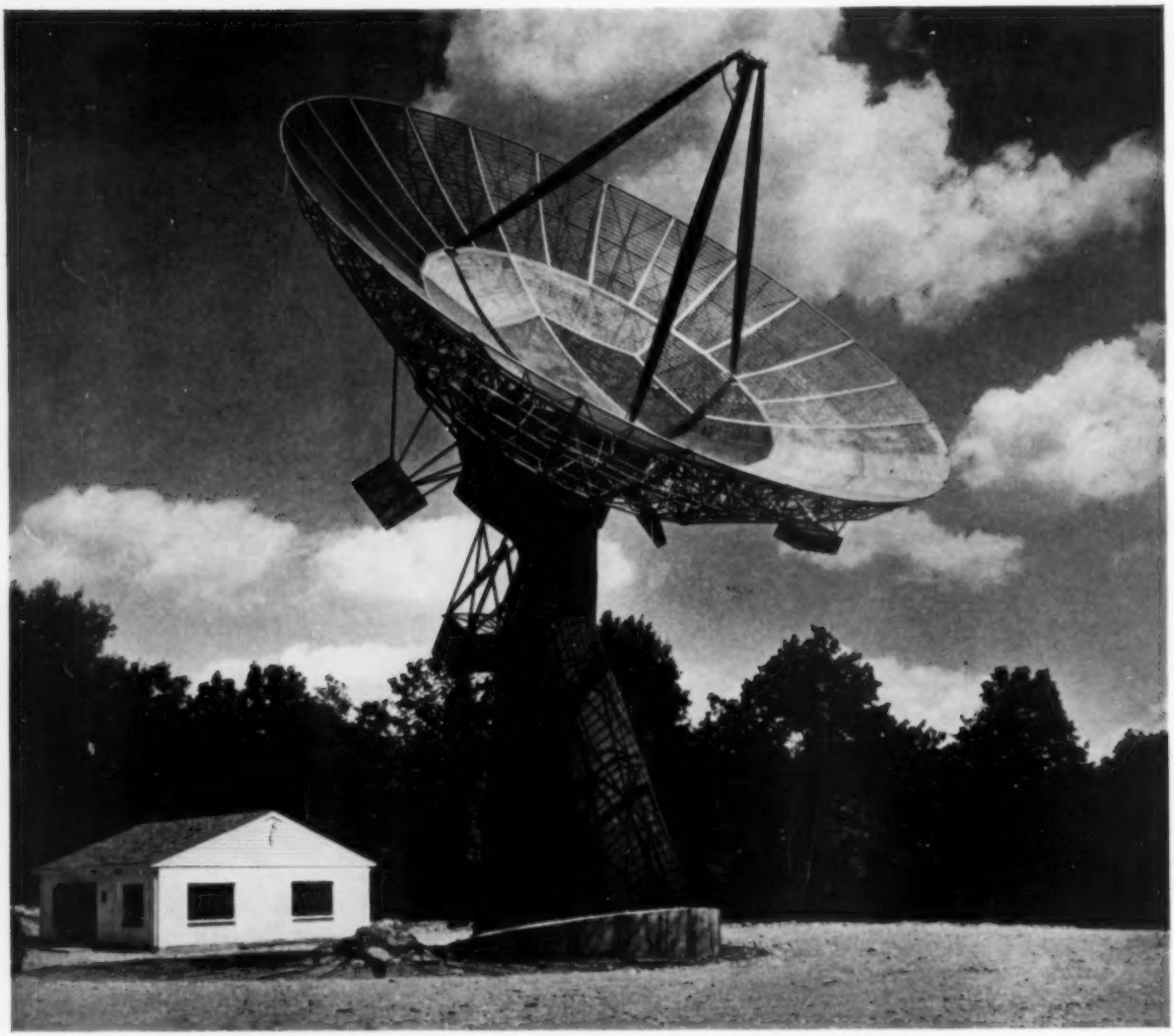
Manufacturer reports, "We are extremely pleased with this purchased 'extruded' jaw stock. We now enjoy a 35% cost reduction on our jaw milling operations . . . and the surprising straightness of the extruded bars improves our product."

Here's how these exclusive J&L steel sections can reduce your costs:

1. Eliminate machining and finishing operations.
2. Reduce scrap losses almost to zero.
3. Eliminate cost of casting and forging intricate sections.
4. Reduce inventories because extrusions are quickly available.

Investigate this new production technique for your shape profiles—within present limits of a design which can be inscribed in a three-inch circle. You'll surely boost production, cut over-all cost. For complete details write to the Jones & Laughlin Steel Corporation, Dept. **409,** 3 Gateway Center, Pittsburgh 30, Pennsylvania.

Jones & Laughlin STEEL ...a great name in steel



What a radio telescope can tell you about expanded aluminum

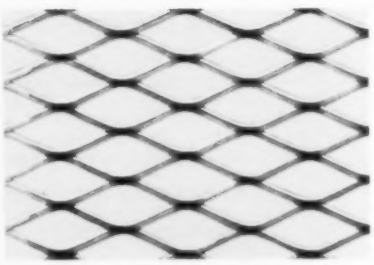
In designing Harvard University's new 60-foot radio telescope, the D. S. Kennedy & Co. found many advantages in Penmetal expanded aluminum. These include . . .

Openings of just the right size: Small enough to present an effectively solid surface to the radio signals; large enough to minimize wind resistance.

Corrosion resistance: To provide 'round-the-clock weather protection.

Inherent structural strength, which helps to prevent distortion with movement of the reflector, and reduces the bracing required.

Light weight: As the mesh covers the entire area of the reflector, the fact that it weighs only a fraction



of a pound per square foot was an important consideration.

Low cost, which enabled the large area to be covered economically.

Easy fabrication with standard tools.

These same characteristics have made Penmetal expanded aluminum the choice for a wide variety of applications. It is available in a number of different mesh sizes to suit almost any requirement.

Write for descriptive folder. Ask for a copy of 507EM.

PENN METAL COMPANY, INC.

General Sales Office:
40 Central Street, Boston 9, Mass.
Plant: Parkersburg, W. Va.
District Sales Offices: Boston, New York, Philadelphia, Pittsburgh, Detroit, St. Louis, Dallas, Little Rock, Seattle, San Francisco, Los Angeles, Parkersburg

Penmetal

PM-143

TAYLOR
Laminated Plastics
Vulcanized Fibre

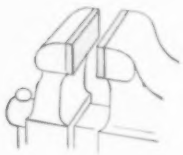
Shop Talk

TAYLOR FIBRE CO.
Plants in Norristown, Pa. and La Verne, Calif.

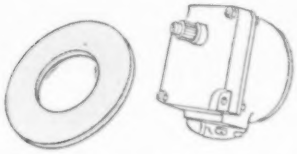
PHENOLIC—MELAMINE—SILICONE—EPOXY LAMINATES • COMBINATION LAMINATES • COPPER-CLAD LAMINATES • VULCANIZED FIBRE

Tips for designers

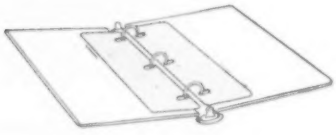
Back plate on an automobile headlight switch, punched and machined from Taylor Grade XP paper base laminate, has low moisture absorption and good dielectric strength.



Vise jaw caps, made of Taylor Grade C phenolic laminate, are easily cut and machined to shape. Marring of precision or delicate parts is eliminated.



Self-balancing servo motor has stator case insulator which is cold-punched from ⅛" thick Taylor Paper Base Phenolic Laminate sheet.



Flippers for loose-leaf binders are made of economical Taylor Vulcanized Fibre . . . affording added rigidity and good protection for the paper pages.

TAYLOR SUPERIOR COPPER-CLAD LAMINATES

Taylor GEC (glass epoxy) Copper-Clad and Taylor XXXP-242 cold punching (paper-phenolic) Copper-Clad. Taylor uses high purity rolled copper on base materials with outstanding electrical properties.

Time switch, made by the Tork Clock Co., uses two Taylor products . . . the deadfront is made of vulcanized fibre for its insulating properties, shock protection and printability . . . the mounting panel of the clock is made of Taylor laminate XP-1-231, chosen for high strength and good punchability.

Have an Insulation Problem?

Taylor will provide the answer . . .

Select from Taylor's complete line of materials—laminates and vulcanized fibre—to get the right combination of electrical, physical and machining properties for your product. And, if you have a unique problem, Taylor will develop a special material to meet your requirements.

For example, rigid requirements for insulation materials in the Tork Clock Company's Time Switch were met by two Taylor materials—a laminate and vulcanized fibre. The mounting panel is made of Taylor laminate XP-1-231, especially formulated for the high strength and good punchability requirements of this application. In addition, Taylor vulcanized fibre serves as the deadfront—a shockproof cover removed only for installation and service. Fibre was chosen for its insulating properties, shock protection, and printability.

Taylor materials are developed to meet the need for dependable, moisture-resistant insulation. They have high dielectric and mechanical strength, and maintain original characteristics over long periods of time, under severe operating conditions. When you choose—and use—Taylor products, you'll have performance with stability.

Taylor application engineers can help you obtain the Taylor material that matches the exact requirements of your product. Contact your nearest Taylor sales office.

GREATEST VERSATILITY

HYDRAULICS in AUTOMATION

No place for down-time

that's why **CROSS** specifies HYDRALUSTER tubing exclusively!

Hydraluster tubing is carrying the vital load of hydraulic transmission in this 350 ft. Cross transfer machine. Hydraluster is there because *every* part and assembly has to be 100 per cent dependable. There is too much at stake for anything less.

Why does Hydraluster get the call? . . . because it is a revolutionary improvement over any previous type of hydraulic tubing. *Inside*, Hydraluster has a new type of tubing surface, very much like a gun barrel. This smoothness cuts friction and heat, and the result is higher power efficiency and lower reaction times. This new surface is also highly resistant to oxidation and scale . . . added protection for valves, pumps and meters.

Here we quote Mr. Ralph E. Cross, Executive Vice President of The Cross Company. "*We've used Summerill Tubing for years because we felt it was the best. And when Summerill topped even their best with Hydraluster, it was only logical that we go along with the improvement.*"

*Stations—104. Operations—265 drilling, 6 milling, 21 boring, 56 reaming, 101 countersinking, 106 tapping, and 133 inspection.

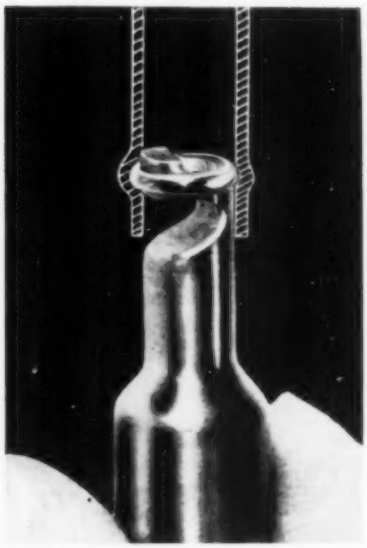
SAMPLES and SPECIFICATIONS: Examine Hydraluster right at your desk or board. Your name on company stationery will bring samples and specifications.

Summerill

Tubing Company Division-Columbia Steel & Shafting Co.

PITTSBURGH 30, PA. DEPT. NO. 6-11

District Offices: Buffalo • Chattanooga • Chicago • Cleveland
Dayton • Hartford • Los Angeles • Philadelphia • Pittsburgh • Milwaukee • San Francisco



in the tube. Tightening the molded nylon fitting completes the operation. Danielson Mfg. Co., Danielson, Conn.

For more information—
Circle 110, inside back cover

Low Pressure Reducing Regulator

A low pressure reducing regulator can be used to supercharge hydraulic reservoirs, as a lubrication system regulator, or in a canopy seal system. Originally developed for applications in aircraft and missiles, the device is adjustable from 20 to 40 psi. and accurate to better than 5 psi, with flows from slight bleed to 7 cfm.

The regulator weighs 9 oz, and measures $2\frac{1}{16}$ x $3\frac{3}{8}$ x $2\frac{9}{16}$ in. Val-Aero Div., Darco Industries, Inc., 2151 E. Rosecrans Ave., El Segundo, Calif.

For more information—
Circle 111, inside back cover

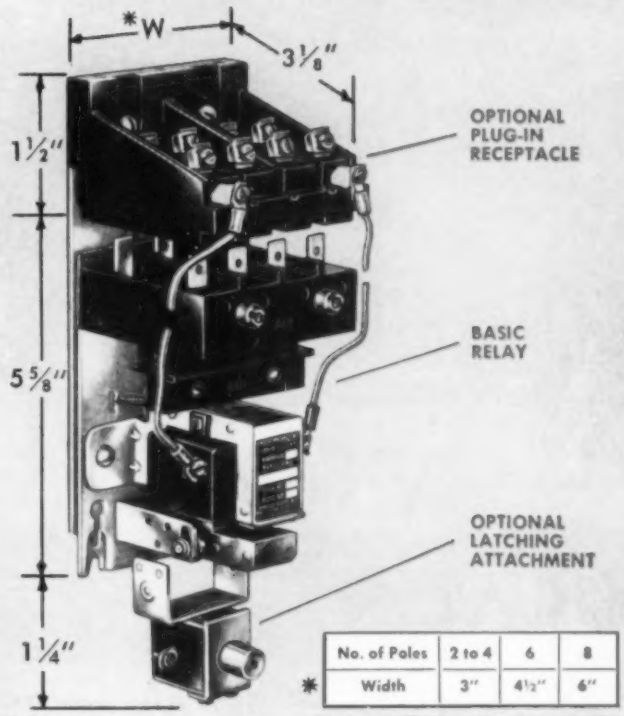
Hydraulic Hose and Couplings

Medium high and high-pressure hydraulic hose and hose couplings which may be used over and over again, bite through the rubber cover and grip either the single or double wire braid hose.

It is not necessary to use a mandrel to flare out the hose in the socket. Since the insert and the end of the hose are both exposed before the socket is engaged to the bushing, the

(Continued on page 356)

GREATEST VERSATILITY EVER OFFERED
in a Single Motor Control Design



*	No. of Poles	2 to 4	6	8
	Width	3"	4½"	6"

New SIZE 00 and 0 RELAYS

600 VOLTS AC 10 and 15 AMPS
2 • 3 • 4 • 6 • 8 POLES

OPTIONAL PLUG-IN RECEPTACLE . . . minimizes down-time on high output machines; relay speedily replaced *without* disturbing wiring.

EASIEST CONTACT CONVERTIBILITY . . . from normally-open to normally-closed. No tools needed.

SIMPLIFIED FRONT REMOVAL OF COIL . . . fastest, easiest method of removing coil ever devised. Just remove 2 screws, swing to front, and lift out entire assembly.

HANDIEST LATCHING ATTACHMENT . . . another A-H exclusive, allows quick conversion to latching type relay . . . the *only* such single attachment quickly convertible in the field from "latch-in" to "latch-out" or "latch-in-and-out."

Available with AC and DC holding coils.

For complete information, write to The Arrow-Hart & Hegeman Electric Company, 103 Hawthorn St., Hartford 6, Connecticut.

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Quality since 1890
MOTOR CONTROLS • ENCLOSED SWITCHES
APPLIANCE SWITCHES • WIRING DEVICES

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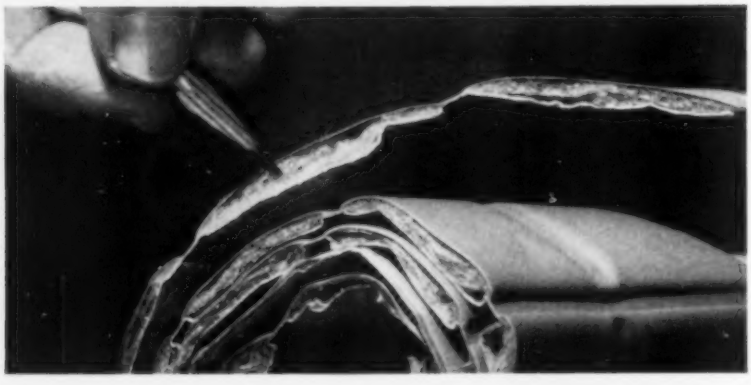
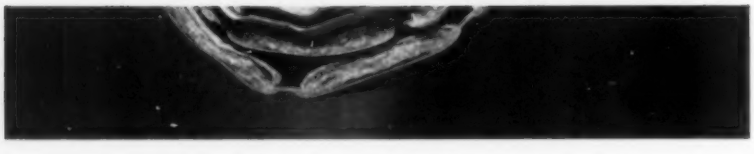
Low-Cost Backing Material Cuts Upholstery and Backing Costs



FELTERS ALLFAB



AllFab is a revolutionary fabric of cardable fibers like wool, rayon, cotton, dynel, nylon and dacron combined with a resin binder.

This thermoplastic binder has two big advantages: (1) AllFab will hold and give dimension to any embossed pattern, and (2) it is possible to electronic "stitch" or heat seal, eliminating sewing.

Result: A felt-like fabric with a tremendous range of fiber combinations, using selections of diameters, lengths and gravities to meet your own specifications.

Find out about this brand new all-purpose, non-woven fabric NOW. Put its special properties to use as a low-cost filler and backing material. Call sales office nearest you, or send coupon below.

Properties

Can use almost any cardable fiber or combination • Vary resin content from 15-45% • Thickness from 1/16" to 1", specialties to 2" • Weight from 4 oz. to 16 oz. and up • Width from 16" to 80" but 72" preferred • Color within mix limits, natural shades

One of the new family of Felts...

Heart Felt ®	MiraFelt ®	Cut Felt Parts
Filon d'Or ®	AllFab ®	and Unisorb ®
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Another Fabric First in . . .

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Manufacturers of Felt and Felt Products

FE 7-17

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228 South Street, Boston 11, Mass.

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(Please Print)

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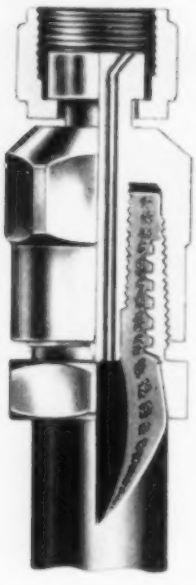
City.....Zone.....State.....



insert can be "rolled" into the hose without a possibility of gouging according to the manufacturer. Operating temperature range is −40 F to 275 F, and burst pressure range is 1,400 to 18,000 psi. Stewart-Warner Corp., Alemite Div., 1826 Diversey Parkway, Chicago 14, Ill.

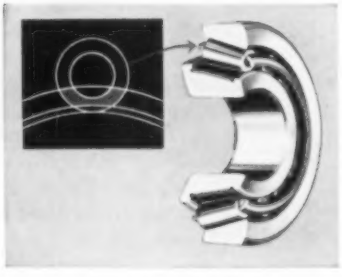
For more information—
Circle 112, inside back cover

Relief and Back Pressure Valve

A spring-loaded relief and back pressure valve designed to function on both condensing and non-condensing systems is used to maintain constant

(Continued on page 358)

Tomorrow's "dream" is our job today!



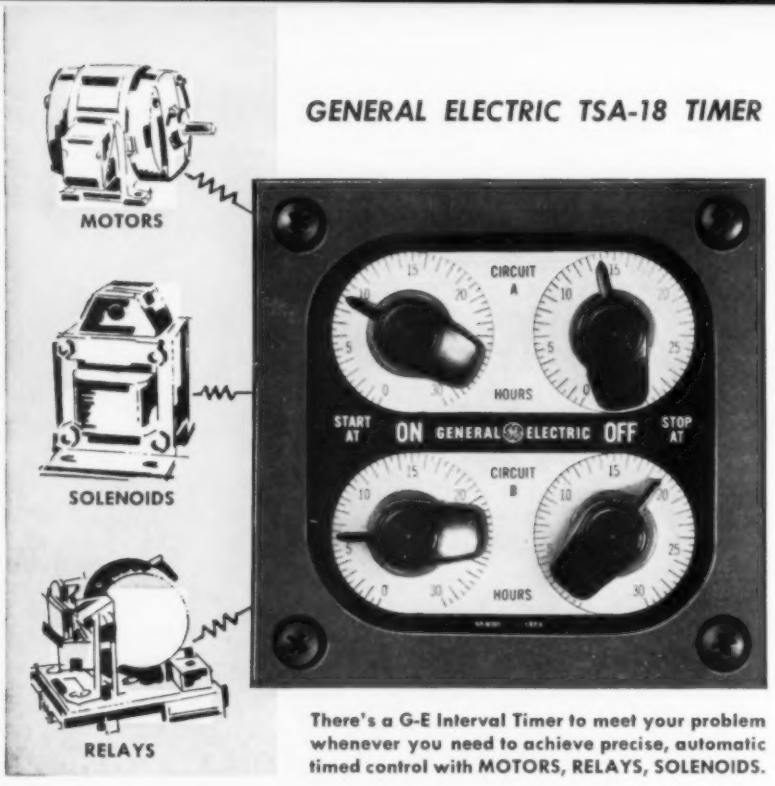
HIGHER FLANGE IMPROVES ROLLER ALIGNMENT

As shown by the gray area above, the higher flange provides a large two-zone contact area for the roller heads. This greatly reduces wear—practically eliminates "end play". Larger oil groove provides positive lubrication.

There's more to the car of tomorrow than just futuristic styling! Automotive engineers are working to perfect completely new power plants—like turbine engines—to achieve yet-unheard-of performance and economy! And they demand bearings that are as advanced as their thinking. This is no new challenge to Bower engineers. A glance at the design features listed at left will tell you a few of the many original Bower contributions to bearing performance which have reduced bearing maintenance and failure to a practical minimum. There are many more in the making. If your product is one which needs advanced bearings *today* plus realistic planning for the future, specify Bower. There's a complete line of tapered, straight and journal roller bearings for every field of transportation and industry.

BOWER ROLLER BEARING DIVISION
FEDERAL-MOGUL-BOWER BEARINGS, INC. • DETROIT 14, MICHIGAN

BOWER ROLLER BEARINGS



There's a G-E Interval Timer to meet your problem whenever you need to achieve precise, automatic timed control with MOTORS, RELAYS, SOLENOIDS.

Save Money, Manpower with Automatic Timed Control of Machines and Processes

On all machines or process equipment where time or timing cycles are an important factor, General Electric TSA-18 Timers can reduce operating costs by freeing operators for more productive work and reduce waste and spoilage of material.

USED FOR THE AUTOMATIC start/stop of motors and the timed control of solenoids and relays, the TSA-18 offers you reliable control of time cycles, or combinations of time cycles, from 30 seconds to 30 hours. Setting accuracy of 1%, and repeat accuracy of ¼% assure precise control for the most critical applications. When required, the standard TSA-18 timer may be equipped with automatic reset and automatic recycling.

138 DIFFERENT MODELS of the TSA-18, plus many varied combinations of wiring, assure you of obtaining the exact time control, or combinations of time control, needed for your particular application. No matter what is required—regular interval timing, remote actuation, automatic resetting, automatic recycling, or sequential operation of several timers . . . they're yours with the TSA-18.

FOR INFORMATION as to exactly how the TSA-18 timer can save money and manpower on your machines or process equipment, contact your nearby G-E Apparatus Sales Office . . . or write for bulletin GEC-1223 to General Electric Co., Section 584-11, Schenectady 5, New York.

GENERAL ELECTRIC

back pressures in the exhaust line from an auxiliary engine or turbine. On the condenser of any auxiliary equipment it functions as a relief valve if the vacuum is lost. In non-condensing systems, the valve serves as a back pressure control valve.

The valve is available from 2½ to 6 in., with adjustment ranges varying from 5 to 35 psi. Bronze, steel or iron bodies are obtainable. The valve can be opened manually, and by turning the handwheel until the spring is no longer under compression, the disc can be lifted from its seat. Seat and disc are made of stainless steel or bronze. Atlas Valve Co., 280 South St., Newark 5, N. J.

For more information—
Circle 113, inside back cover

Poppet-type Control Valves

Pilot-operated, poppet-type, in-line control valves, designed for brake, clutch and other high speed applications, are available in two and three-way models. These valves are said to provide split-second response as a result of short poppet travel.

The poppet is air-cushioned and no springs are used in the valve body. A standard solenoid pilot operates the poppet. Pilots are built to JIC standards. A cast Navy M bronze valve body, stainless steel moving parts and Hycar sealing materials are used.

The valves are offered in normally open and normally closed arrangements, with integral pilots or for remote pilot operation. Sizes are from ¼ to 1 in. NPT for working pressures of 10 to 200 psi. Solenoid pilot coils for a-c or d-c, any voltage, are available. Valvair Corp., 454 Morgan Ave., Akron 11, Ohio.

For more information—
Circle 114, inside back cover

Cylinders for Air, Water, Hydraulic Service

The cylinders are available with bores of 1½, 2, 2½, 3 and 4 in. and with either single-ended or double-ended rods. All sizes are also available as double-acting cylinders or single-acting spring return units.

The cylinders have either brass or

(Continued on page 362)

OHIO SEAMLESS TUBING

SPEEDS UP DRILLING 25%

Pennsylvania Drilling Company, Pittsburgh, manufactures drilling equipment for foundation testing, mineral prospecting and other drilling, boring and sampling operations. Recently they introduced a new Flush-Joint Drive Casing made from cold drawn OSTUCO Seamless Steel Tubing.

The new casing stepped up overall drilling progress 25%—driving and pulling is easier and quicker. Flush-Joint Casings are stronger, too—actually 50% less breakage . . . with resultant savings in downtime, repair and material costs. Success with the new casing led to its incorporation in Penndrill's newly-designed Testborer which augers, automatically samples and drives and core drills.

There's a good chance OSTUCO Tubing components can improve the performance of your product. You can start the process by contacting the nearest Ohio Seamless sales office, or by writing direct to the Shelby factory.

OSTUCO SHELBY, OHIO

OSTUCO TUBING

MANUFACTURED IN

SHELBY, OHIO

EXCLUSIVELY BY

OHIO SEAMLESS TUBE DIVISION

OF COPPERWELD STEEL COMPANY

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CANADA: Railway & Power Engr. Corp., Ltd.

EXPORT: COPPERWELD STEEL INTERNATIONAL COMPANY, 225 Broadway, New York 7, New York

CASE HISTORIES FROM MT. VERNON FILES

RONSON produces the First Electric Shaver with 2 Separate Cutting Heads

Ronson calls their new "66" Shaver "the most revolutionary electric shaver ever designed"—and offers strong evidence to support this claim. For one thing, it is the first electric shaver with an extra cutting head, called "Super Trim", which does every trimming job, from sideburns to mustache.

When any manufacturer is out to break precedent, and still sell his product at a competitive price, he needs every bit of designing and production skill he can find—anywhere.

Ronson found these in generous abundance at Mt. Vernon. Three of the vital parts of the "66"—the head frame and the plate covering the "Super Trim" blades (zinc castings), and the motor chassis (an aluminum casting)—were designed to obtain the special advantages of die casting: thin wall sections of great strength and rigidity, negligible machining, smooth finish, high speed production, low cost.

Says Ronson: "These parts are highly vital to our electric shaver. The cutting mechanism depends on the head frame for its accuracy of mounting and rigidity while cutting. The chassis on which the motor is built is of course the heart of the shaver's power system, and a very accurate casting is necessary for the job."

These advantages, important to any manufacturer, stem directly from the way we are organized here at Mt. Vernon. We have both the facilities and the complete die casting service it takes to produce parts like these, in any quantity, at minimum cost. We have 200,000 square feet of the most modern equipment for making dies and for die casting aluminum and zinc. And Mt. Vernon service comprises completely coordinated designing, die-making, casting, and machining, all under one roof.

It will pay you well to bring your production specifications to us. We may show you, as we did Ronson, the way to important cost reductions and improved products.

MT. VERNON
DIE CASTING CORP.
STAMFORD, CONNECTICUT

SALES REPRESENTATIVES

Mr. Grant Eller
6 East 194th St., Cleveland, Ohio

Mr. Jerome J. Theobold
9 East Genesee St., Skaneateles, N. Y.

Mr. Arthur Diamond, Tools Incorporated
86 Bethlehem Pike, Philadelphia, Pa.

Mr. Anker Anderson
Cascade Road, Stamford, Connecticut

Mr. William Sauers
101 Briarcliff Road, Rochester, N. Y.

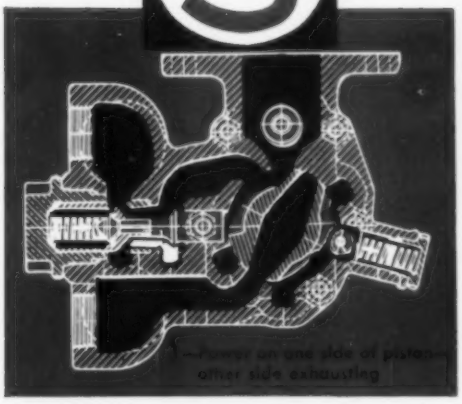
Mr. David H. King
75 Willow Street, Guilderland, N. Y.

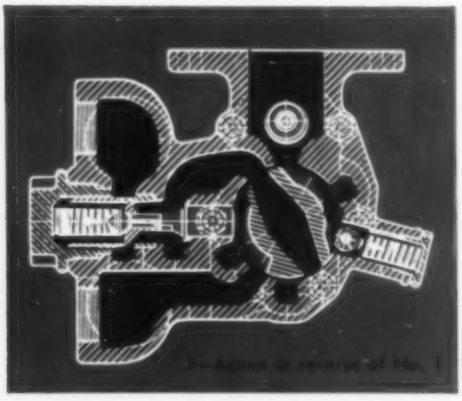
Mr. George E. Hahl
39 South Munn Ave., East Orange, N. J.

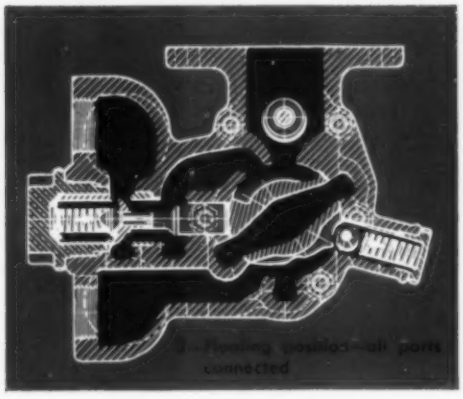
CASH STANDARD

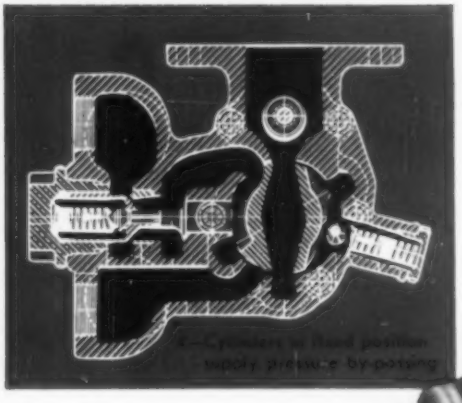
TYPE 555-RO

Four-Way Hydraulic Operating Valve









a unique rotor actuating hydraulic valve with full floating position

A Single Unit For Actuating Hydraulic Equipment

- Actuates one to three hydraulic cylinders
- Designed for 300-1500 psi pressures
- Capacity 40 GPM at 1500 psi
- Built-in by-pass effectively minimizes piston creep
- Design features ball-bearing construction and hardened wearing surfaces
- Rugged construction and precision machining assures easy operation and long service

WRITE today for Bulletin S-600

U. S. Patent No. 2360987

CASH STANDARD

A. W. CASH COMPANY, P. O. Box 551, Decatur, Illinois

Pressure, Hydraulic, Temperature, Process and Combustion Controls

Our special business is specials . . . special fabricated wire cloth parts made to your specifications. We save you time, we save you overhead, we save you production worries. And, you get a better part at a lower cost.

We weave our own cloth . . . your guarantee of quality components. We are fully equipped to do all necessary cutting, shaping, fitting, welding, soldering, punching, binding, etc.

For more information on this "One-Stop" Wire Cloth Parts Service, send for our latest Parts Catalog.

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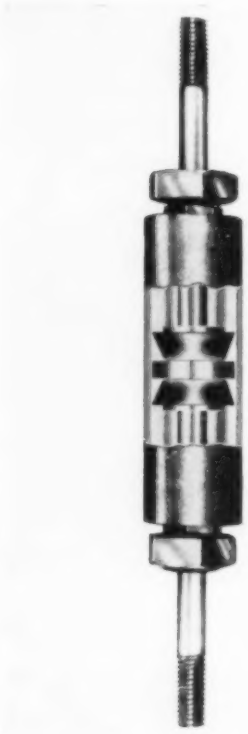
Newark Wire Cloth COMPANY

351 VERONA AVENUE • NEWARK 4, NEW JERSEY



steel barrels, stainless steel rods and nylon-lined bearings. Cushions are available for both ends as well as interchangeable foot, flange and swivel mounts. A. K. Allen Co., 57 Meserole Ave., Brooklyn 22, N. Y.

For more information—
Circle 115, inside back cover

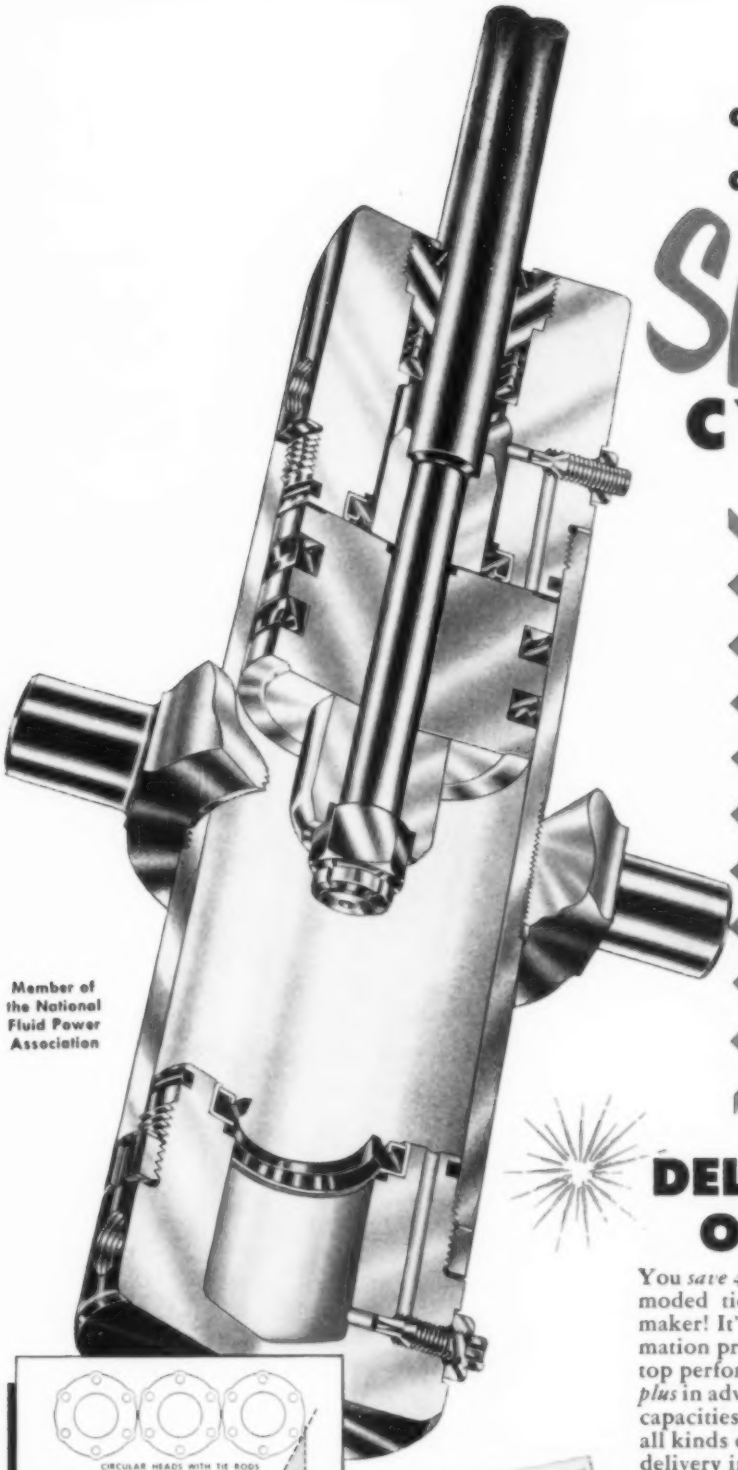
Servo Hydraulic Valve

This valve provides repetitive reversal of flow to work element; automatic cycling; hydraulic lock, with locked-in, equal opposing pressures; free-wheeling, with no pressure or flow restriction. Energized by the hydraulic circuit flow, the valve, which is actuated by feedback control, will either function precisely; or in case of mechanical or circuit malfunction, shuts down before reaching reversal point. Positive limit stops can be used since over-travel cannot occur in the valve function.

Signal reception demand is in ounces of force applied; and since functions are based on metered incremental displacement of the hydraulic fluid, the reversal action is not sensitive to pressure, or flow, variation. Accuracy of reversal remains uniform with pressure

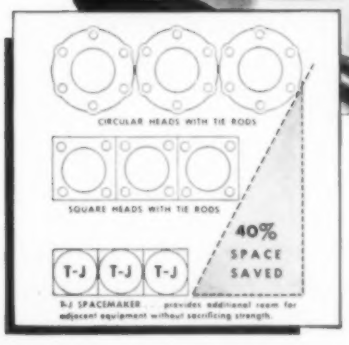
(Continued on page 366)

all the EXTRAS are standard with T-J Spacemaker CYLINDERS



Member of the National Fluid Power Association

- **NEW** *exclusive* ingenious cushion designs . . . Super Cushion Flexible Seals for Air . . . New Self-Aligning Master Cushion for Oil.
- **STRONGER** than outmoded tie rod design, proven through actual tests. No tie rods to stretch.
- **SOLID STEEL HEADS** throughout the full line.
- **COMPACT DESIGN** eliminates tie rods, increasing the strength and reducing mounting space required, providing extra room for adjacent equipment.
- **HARD CHROME PLATED** body bores and piston rods . . . assure you of long trouble-free service. (Standard at no extra cost.)
- **METALLIC ROD SCRAPER,** not just a wiper, actually removes foreign matter from the rod.
- **PILOTED PACKING GLAND** with extra long bearing. Additional strength and support to the piston rod.
- **OIL** pressure to 750 p.s.i. AIR to 200 p.s.i.



DELIVERY OFF THE SHELF!

You *save 40% space* when you switch from outmoded tie rod cylinders to the T-J Spacemaker! It's stronger, too! Fits right into automation programs in countless plants. Delivers top performance and dependability with a big *plus* in advanced features. Wide range of styles, capacities . . . reduces man-hours and costs in all kinds of push-pull-lift operations. Off-shelf delivery in 64,000 combinations!

NEW LITERATURE—Send today for new Catalog SM56 with complete engineering details on Spacemaker line. Write The Tomkins-Johnson Co., Jackson, Mich.

T-J TOMKINS-JOHNSON

RIVETORS · AIR AND HYDRAULIC CYLINDERS · CUTTERS · CLINCHORS

Flash-Butt Welding

How to Use It to Improve Product Design and Quality

What is Flash-butt Welding?

Flash-butt welding is a resistance welding process for end to end joining of rods, tubes, bars, forgings, fittings, etc., to achieve the greatest possible strength. It is accomplished by positioning the pieces to be joined with clamping electrodes so that there is initially light contact between abutting edges (Fig. 1).

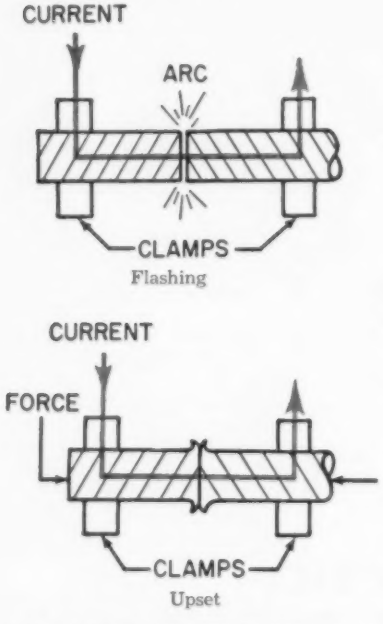


Fig. 1. Flash-butt welding process.

Introduction of the current causes flashing which generates great heat. As the metal is burned away the pieces are moved together in an accelerating motion. Thus, uniform flashing action is maintained for the most efficient heating process. When the inner faces obtain the proper temperature, they are forced together under high pressure and the current is cut off. The impurities (oxides, slag, etc.) formed during flashing are forced out in the upset action leaving pure base metal to form a high strength bond (Fig. 3).

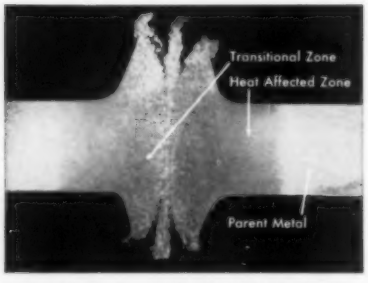


Fig. 2. Macrograph of 2" O.D. x .095" wall of 4140 alloy steel tubing flash-butt welded on a Sciaky Type BMW. 3-400 machine.

Advantages of Flash-butt Welding

Flash-butt welding offers a 100% strength factor compared to 80% strength factor for flame and arc welds. Further, no extra material such as gas, rod, or flux is required. *The material itself forms the weld.*

Flash-butt welding has low power demand and power consumption. Higher production speeds are more readily achieved with this process than with any other fastening method. The localized heat minimizes part distortion. Generally, no special preparation of the weld surfaces is required.

Simplicity and effectiveness of the Sciaky Flash-butt weld technique reduces multi-step fastening operations to just one. One operator (not skilled) can consistently produce high quality welds.

Dissimilar metals with widely varying melting temperatures are easily flash-butt welded.

Fig. 3. Destruction test on extruded aluminum miter joint. Note that failure is in parent metal, not in the weld.

When to Design for Flash-butt Welding

Whenever ideal flash-butt welds are required, the size and shape of the parts to be welded should be identical. However, a maximum of 15% variation in end dimension is usually permissible for commercial usage. New applications for this process are opening up every day. Often little, or no change in existing design allows conversion to high production flash-butt welding.

New Research Center for Your Design Problems

Sciaky's new three-quarter million dollar Research Center is equipped with the most advanced resistance welding machines, testing instruments, and trained personnel. The entire facility is devoted to solving *your* joining problems and advancing the application and development of resistance welding. The Research Center invites *you* to submit your fastening design problems.

Build Your Data File with Free Sciaky Literature

Write today on your company letterhead describing your particular field of interest. We will send suitable back issues (as well as future issues) of our "Resistance Welding At Work" publication, showing typical design problems solved by this method of fastening. All contain impressive case history examples of Sciaky basic thinking—resistance welding techniques designed to do more *useful work* at *lower operating costs* with *maximum reliability.*

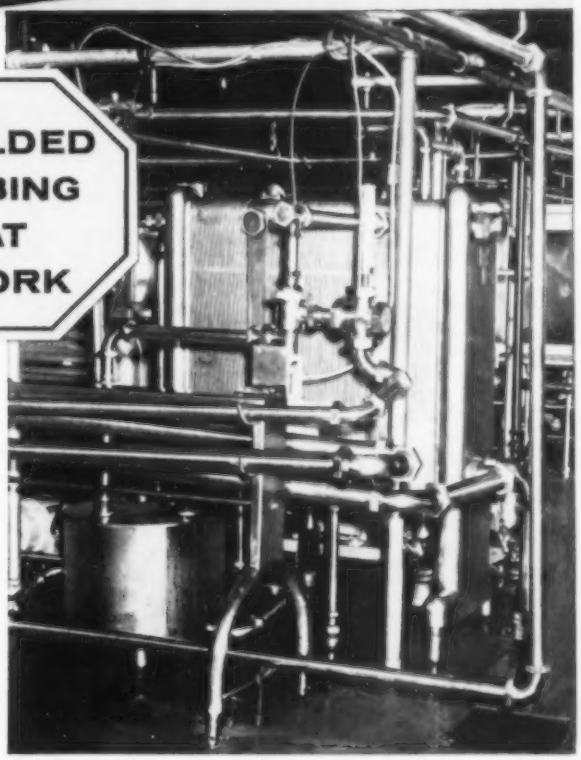
Largest Manufacturers of Resistance Welding Machines in the World

SCIAKY

Sciaky Bros., Inc., 4913 West 67th Street, Chicago 38, Ill., Portsmouth 7-5600

Design with TUBING in mind!

WELDED TUBING AT WORK



Once machined from solid bar stock, this machine gun flash hider was produced at a 92% saving in cost by forming from Welded Carbon Steel Tubing.

Positive sanitation, non-contaminating, non-corrosive, non-breakable —all these call for Welded Stainless Steel Tubing in hundreds of Pasteurizers like these and all sanitary services.

Reduce fabricating costs—Insure purity

CHOOSE WELDED STEEL TUBING

Carbon · Alloy · Stainless Steel

Easy workability, outstanding uniformity, wide range of grades make Welded Tubing applicable to nearly every use requiring a hollow part. Whether a mechanical component, a structural use, to convey liquids or gases, or move at high RPM—there is a grade, size and shape of Welded Tubing that will do your job best. For all tubing applications, consult a quality tube producer.

An Association of Quality Tube Producers

FORMED STEEL TUBE INSTITUTE FSTI

Design inspiration for you

The 260-page Handbook of Welded Steel Tubing contains inspiration and data for tubing designs. For your copy, write on your company letterhead, giving your title.

FORMED STEEL TUBE INSTITUTE
850 HANNA BUILDING • CLEVELAND, OHIO

Bourns NEW TRIMPOT JR.*

- micro-miniature size
- high power rating
- humidity proof

*Trade Mark

This micro-miniature potentiometer is designed for use with printed circuit boards and modular-type assemblies, and is derived from Bourns' original TRIMPOT.® The new TRIMPOT JR. is only 3/16" x 5/16" x 1" in size. Seventeen units can be mounted in one square inch of panel space. Power rating is 2 watts, and maximum operating temperature is 175°C.

The TRIMPOT JR. is built to meet or exceed government specifications for humidity, salt spray, vibration, acceleration, and shock. This potentiometer features a 15-turn screwdriver adjustment and 1½", 0.016" diameter leads. The shaft-clutch assembly idles when the mechanical limits are reached, thus preventing possible damage from forcing of adjustments. The TRIMPOT JR. is mounted with 2-56 screws through stainless steel eyelets on ¾" centers.

Deliveries from stock. Send for complete data: Bulletin JR.

COPR. BL

BOURNS LABORATORIES, INC.

General Offices: 6135 Magnolia Avenue Riverside, California
Plants: Riverside, California—Ames, Iowa

TRIMPOT • LINEAR MOTION POTENTIOMETERS • PRESSURE TRANSDUCERS AND ACCELEROMETERS

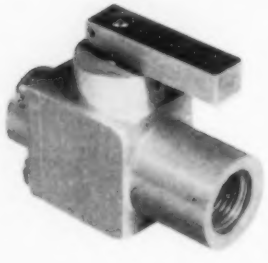
differentials from 5 to 2000 psi. Vanguard Engineering, 51 Washington Ave., Cranston 7, R. I.

For more information—
Circle 116, inside back cover

Nozzle for Hollow-cone Spray Pattern

Spray nozzles with a range of capacities from 1.5 to 1100 gpm provide at 40 lb pressure a spray with a 30° spray angle. Pipe connection sizes ¼ to 5 in. are made in brass, steel and stainless steel. Spraying Systems Co., Randolph St., Bellwood, Ill.

For more information—
Circle 117, inside back cover



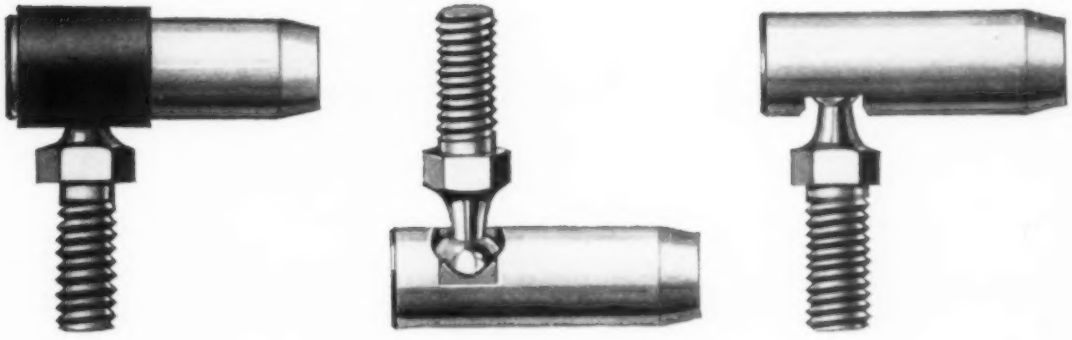
Straight-Through Ball Valves

Manually operated ball valves are said to provide bubble-tight control of media at pressures up to 3000 psi. Operating temperatures of −320 F to 650 F are withstood by the mechanical design and critical sealing parts. Suitable for hydraulic fluids, fuels, oxidizers, water, oils, air, and many other liquids and gases. Available for

(Continued on page 370)

Transmit Motion This Positive Low Cost Way!

NEW TOUREK TYPE "F" BALL JOINTS



Where the higher cost of adjustable ball joints has made necessary the substitution of clevises, trunions, bent rods, or other less effective means of transmitting motion, it is now possible to consider the use of Tourek Type "F" Ball Joint, *a low cost trouble-free joint*—carefully, yet simply designed, which can be interchanged with present SAE Standards.

The construction of this Ball Joint is of a non-adjustable type, permitting a minimum 15° movement in any direction.

Ball Screw wear surface is machined into the shell, eliminating the necessity of providing adjustable top caps, cotter pins, sleeves, clips, or other retaining devices. By removal of these parts, a Ball Joint is obtained with no protruding sharp edges and no removable component parts which might become lost. Tampering after installation is minimized and a long wearing, dependable assembly is assured.

This unit may also be supplied with a rubber neoprene dust cover, hardened ball screw and wear surface on shell, and pre-packed with Lubroplate.

Type "F" Ball Joints can presently be supplied to accommodate thread ranges from #10 to 3/8". If your application requires larger sizes or variations from our standard specification our engineers will gladly propose a Ball Joint for your particular need.

Continued research by our skilled engineering staff assures constantly improved Ball Joint designs. The superiority of TOUREK "STANDARD" Ball Joints results from the accumulated experience of more than thirty seven years of development and low cost mass manufacturing. Ask for the Tourek Ball Joint catalog on company letterhead, please.

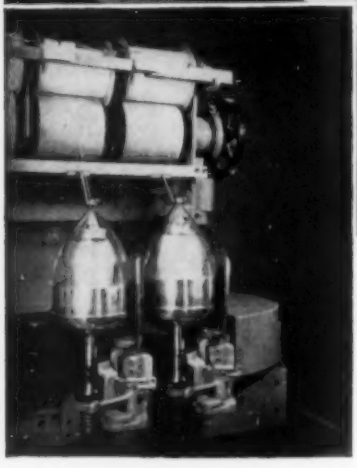
Tourek
BALL JOINTS
The Recognized "STANDARD"

J. J. TOUREK MFG. CO.

1901 SOUTH KILBOURN AVENUE, CHICAGO 23, ILLINOIS

World's largest manufacturer of "STANDARD" Ball Joints. Also makers of Pipe Plugs and quality Screw Machine Products. Range: up to 2⅝" diameter single and multiple spindle machines. Operations include: Threading • Tapping • Milling • Drilling • Grinding • Polishing • Plating • Heat Treating • Silver Soldering.

ESTABLISHED 1920



Wherever you want to protect something
. . . that's a place for A-L Stainless Steel

In a textile plant, like the applications pictured above, Allegheny Ludlum Stainless Steel protects against off-colors in the dyeing and finishing department because it cleans up easily and quickly from batch to batch, leaving no traces of the previous dyes. In yarn twisters and other equipment in the weaving department, A-L Stainless provides the hard, smooth surface and high abrasion-resistance that protects against snagging and binding.

Food, beverage, dairy, drug and chemical plants use A-L Stainless Steel to protect the purity of their products; hospitals, hotels and restaurants use it to protect appearance and sanitary standards; cars, trains and planes use it to protect strength and safety. And they all gain a host of bonus benefits from stainless steel, too: such as far less cleaning and maintenance expense, far longer life in service, and far greater economy in the long run.

No other metal can match stainless steel in these qualities. In addition, A-L Stainless is easy to fabricate and we produce it in every form or shape that you may require.

● Let us help you to profit by it. ***Allegheny Ludlum Steel Corporation, Oliver Bldg., Pittsburgh 22, Pa.***

Write for your copy of "STAINLESS STEEL IN PRODUCT DESIGN"

40 pages of useful engineering and fabricating data, including practical examples showing where, when and how stainless steel improves design, adds benefits, helps sales.

ADDRESS DEPT. PE-90

For Stainless Steel in ALL Forms—call

Allegheny Ludlum

Warehouse stocks carried by all Ryerson Steel plants

AL® STAINLESS STEEL

How Aeroquip Self-Sealing Couplings Simplify Connection and Disconnection of Fluid Lines

Industrial Type 5100 (wing union nut) or 5110 (hex union nut) for hydraulic fuel, oil, air and water lines.

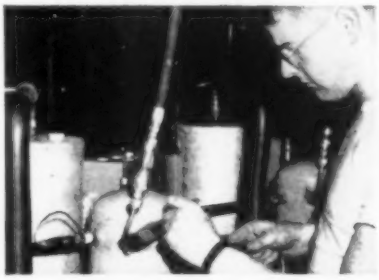
Farm Type 5203 for hydraulic lines from tractor to farm implements.

Freon Type 5400 for precharging air conditioning lines and components at the factory.

LP-Gas Type 5104 for quick recharging of LP-Gas fuel tanks.

Aircraft Type 145-155 and 3200 for all airframe and engine oil, fuel, hydraulic, and pneumatic lines.

Railroad Type 510022 for quick, safe refueling of diesel locomotives.



Soap testing for leaks is speeded up by using an Aeroquip Self-Sealing Coupling to connect a 240 psi air line to a joint.

Fluid systems requiring frequent disconnection and reconnection can be improved and simplified with Aeroquip Self-Sealing Couplings. One Self-Sealing Coupling performs the same function as two shut-off valves. It occupies less space and speeds fluid line connection and disconnection.

All Aeroquip Self-Sealing Couplings have the following basic characteristics:

a. Quick, easy connection and disconnection of pressurized fluid lines, without loss of fluid or inclusion of air or foreign matter into the system.
b. Full fluid flow through connected coupling; leak-proof sealing of disconnected coupling halves under maximum line pressure.
c. Positive locking action on connection to prevent accidental coupling disconnection and flow shut off.
d. Simple, sturdy design, with sufficient valve strength for long, trouble-free operation.

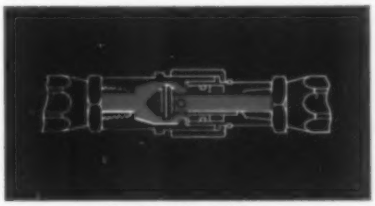
Poppet-Tubular Valve Design

Every Aeroquip Self-Sealing Coupling is designed around mating, spring-loaded poppet and tubular valves. This design principle combines positive sealing action with optimum flow characteristics.

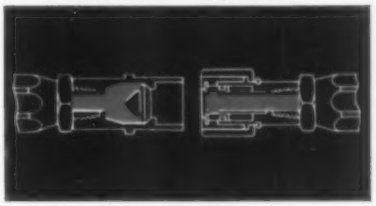
In operation, the poppet valve coupling half mates with the tubular valve coupling half, joined by a quick-threading union nut. Valves open and close simultaneously with the locking and unlocking action of the union nut. Once connected and locked, the coupling cannot unlock accidentally due to vibration and other external forces. Fluid flow through the connected coupling is accomplished with maximum safety and minimum pressure drop.

Many Types Available

No single type Self-Sealing Coupling is ideally suited for the wide range of industrial, aircraft, marine and farm applications. Aeroquip presently manufactures seven types (shown at left) to meet the requirements of varied fluid system use.



Connected coupling—full flow at any pressure.



Disconnected coupling—halves seal at any pressure.

Full information is available. Fill in and mail the coupon below for your copy of "The Case of the Self-Sealing Coupling" plus engineering bulletins on the coupling types to fit your fluid system needs. See our catalog pages in Sweet's Product Design File, Section 6d.

Aeroquip Corporation,
Jackson, Michigan

Please send me a copy of "The Case of the Self-Sealing Coupling", plus the Self-Sealing Coupling engineering bulletins check below:

- ☐ Bul. 165 on Industrial type
- ☐ AEB-14 on Aircraft type
- ☐ IEB-2000 Freon type
- ☐ IEB-21 on LP-Gas type
- ☐ REB-1 on Railroad Diesel Fueling type
- ☐ Bul. 165 on Farm type

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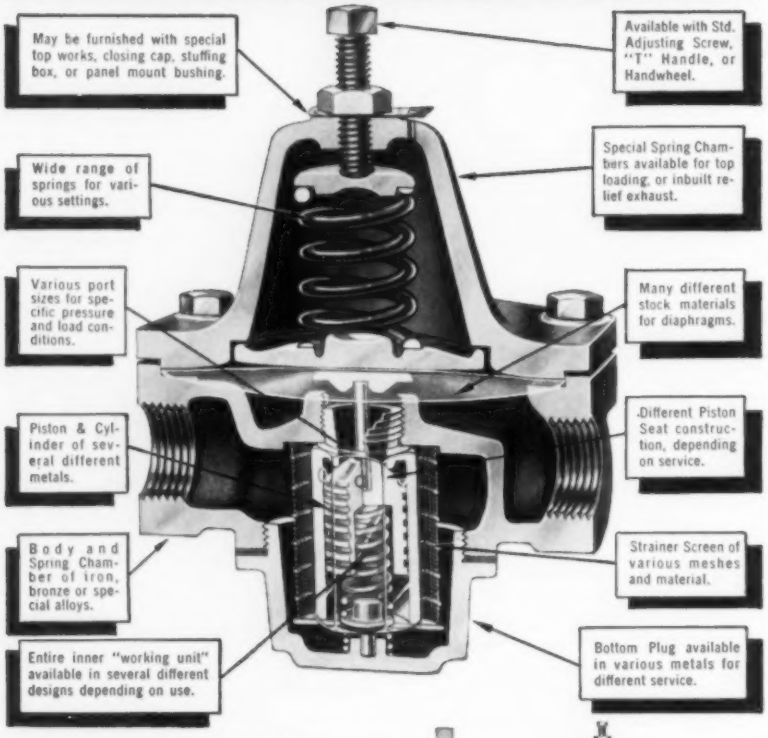
how *Cash-Acme* provides the *Correct Answer* to 1,017 reducing valve cost problems


May be furnished with special top works, closing cap, stuffing box, or panel mount bushing.
Available with Std. Adjusting Screw, "T" Handle, or Handwheel.
Wide range of springs for various settings.
Special Spring Chambers available for top loading, or inbuilt relief exhaust.
Various port sizes for specific pressure and load conditions.
Many different stock materials for diaphragms.
Piston & Cylinder of several different metals.
Different Piston Seat construction, depending on service.
Body and Spring Chamber of iron, bronze or special alloys.
Strainer Screen of various meshes and material.
Entire inner "working unit" available in several different designs depending on use.
Bottom Plug available in various metals for different service.

Here's How: With over 1,017 models and modifications of Cash-Acme's *standard* Type B Pressure Reducing Valve available and already in high production, the *right* regulator can usually be quickly selected from stock to do the job you require. This offers important cost savings as delays, special tooling and custom design and engineering are eliminated.

Do as other cost conscious engineers and purchasing men are doing and switch to CASH-ACME.

A fact-jammed eight-page bulletin, with honest and accurate capacity charts, is available free of charge. Write today.

Type "B"—Rugged Industrial Type Pressure Reducing Valve ...A truly *universal* piece of equipment. Standard models for:

- STEAM
- HOT WATER
- COLD WATER
- AIR
- LIGHT OIL
- NO. 6 OIL
- AMMONIA
- DIFFERENTIAL REGULATOR
- WITH INBUILT RELIEF
- AIR OR OIL TOP LOADING
- PANEL MOUNTING

FOR THE *Correct Answer*

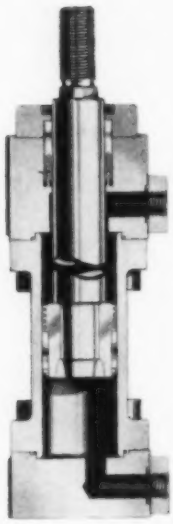
CASH AUTOMATIC VALVES ACME

A. W. CASH VALVE MANUFACTURING CORP.

6662 E. Wabash Ave. Decatur, Illinois

lines from ¼ to 4 in. Typical ⅜ in. valve weighs 0.3 lb. Hydromatics, Inc., Cedar Grove, N. J.

For more information—
Circle 118, inside back cover



Heavy-duty, 3000 Psi Cylinders

These 3500 psi, double-acting cylinders are made of thick-walled, seamless steel. Eight basic sizes are available, 2, 2½, 4, 5, 6, 7, 8 in., with either standard or large diameter rams. Length of stroke varies from 36 up to 158 in., with longer strokes available on request.

Choice of foot lug, center lug, and flange head mountings can be combined or interchanged, front or rear. Oilgear Co., 1560 W. Pierce St., Milwaukee 4, Wis.

For more information—
Circle 119, inside back cover

Fluid Control Valves

Control valves for air, oil or water are designed for pressures of 200 to 5,000 psi, in sizes from ⅛ through ¾ in. A floating retro-ball check provides full flow in one direction; a tapered, fine-thread needle gives a wide range of adjustment of the flow in the opposite, or controlled, direction.

The valve bodies are machined from brass and aluminum bar stock for 2000 psi working pressures; of steel

(Continued on page 375)

No. 3
of a series of ads dealing with basic facts about thermostatic metals.

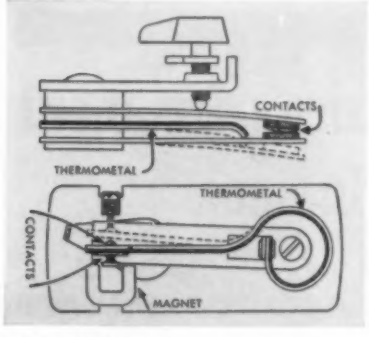
Designing for Product Improvement With WILCO THERMOMETAL®

Thermometal in Temperature Control

Of the several methods of temperature control used in today's industrial and consumer electrical products, Thermometal-actuated units account for a major portion. The reason is—these units offer certain exclusive features which are reflected both in improved design and improved performance in the end product.

Thermometal is a composite material of two or more different metals with unequal coefficients of expansion. This difference causes it to change shape (flex) with changes in temperature, thereby translating temperature change directly into motion.

FLATIRON THERMOSTAT



ROOM THERMOSTAT

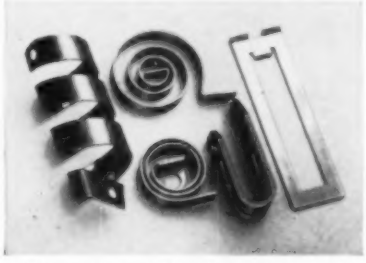
Thermometal is ideally suited for use in temperature controls because:

1. It amplifies temperature change response into motion with no need for complicated linkages such as are used in rod and tube thermostats, or of fluid systems such as diaphragms and bellows.

2. Inherent *economies* resulting from its use in electrical appliances cannot be matched by any other method of temperature regulation.

3. Thermometal facilitates extremely compact design, so that the control unit can be brought close to the source of heat to be controlled. One example of this is the sole plate of an electric iron.

4. With Thermometal, the temperature of an electrically heated source can be controlled without using additional electrical energy in the bi-metal, as is required in operating a thermopile.



Forms in which Thermometal are used

Since Thermometal can be rolled into any thickness and formed into almost any shape it is a unique thermo-responsive element. It enables the design engineer to apply it in the form of cantilever blades, "U" shapes, spirals, and helices, and in almost any mechanical size and configuration according to the physical needs of the temperature control unit. Thus, it is singularly free from many of the limitations of other thermal elements. Typical examples of this are bi-metal thermostats in flat irons and room thermostats.

Factors governing selection

1. Temperature range over which control is required.

2. Maximum and minimum temperature encountered in service.

3. The amount of work (Force times Deflection) to be performed by the Thermometal.

4. Electrical and thermal conductivity required of the Thermometal.

TYPICAL WILCO THERMOMETAL SUB-ASSEMBLIES

The H. A. Wilson Company, American pioneer in the development and manufacture of thermostatic metals, produces over 40 varieties of Thermometal, as well as a complete line of electrical contacts. In many temperature control units both Thermometal and electrical contacts are used. We make a specialty of supplying complete sub-assemblies for these devices, including mounting brackets, pigtails, and other current-carrying members.

Reprints of this series are available on request. For further information about our products, ask for the Wilco Blue Book, the most complete reference manual ever written on Thermometal. And if you have any immediate application problem for Thermometal or other Wilco products, please tell us. Our engineering service is at your disposal.

WILCO®

THERMOMETALS
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COMPOSITE METALS
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MASS SPECTROMETER SEPARATES ELECTRON PARTICLES

This mass spectrometer for basic research in the petroleum industry required an extremely stable, high-intensity field which could be varied.

This assembly, which incorporates a massive 1,300-pound Indiana Alnico permanent magnet, provided the answer. It has a maximum field strength of 6,000 gauss, and stability is maintained without the use of complex control equipment normally associated with electromagnets.

ELECTRONIC "BRAIN" SENSITIVITY DEPENDS ON ALNICO

This electronic computer manufacturer required a permanent magnet housing for the magnetic tape reader and recorder unit of the processing machine in order to improve sensitivity.

Using Alnico for this housing brought on immediate improvement in signal strength . . . and better sensitivity because of the magnet's high efficiency.

NUCLEAR RESONANCE RESEARCH UNIT USES 1,000-LB. MAGNET

The University of Chicago, renown in the field of basic research, required a high intensity magnetic field to extend their research in nuclear resonance.

This huge permanent magnet assembly, containing over 1,000 pounds of Indiana Alnico, produces a field of 6,750 gauss. The stability — an inherent quality of permanent magnets — is maintained without the use of costly controls.

How three unusual products use Alnico permanent magnets plus creative design ... by Indiana

These dramatic examples of the use of Alnico permanent magnets illustrate how the creative engineering and manufacturing skill of The Indiana Steel Products Company have combined to meet the critical requirements of three unusual products.

This same experience can be put to work for you, too . . . regardless of application. Indiana offers the largest staff of magnet engineers and the most complete research and production facilities in the world to assist in the development of permanent magnets for use in your products.

Be sure your new designs incorporate the most efficient and economical magnet! Contact Indiana, today, for engineering assistance and recommendations—without cost or obligation, of course!

You can expect from Indiana:

- Uniform, high energy magnets
- 24-hour service on "stocked" Alnico V magnets for your product development work
- Engineering assistance with new magnet designs—no cost or obligation
- World's most complete magnet production and research facilities

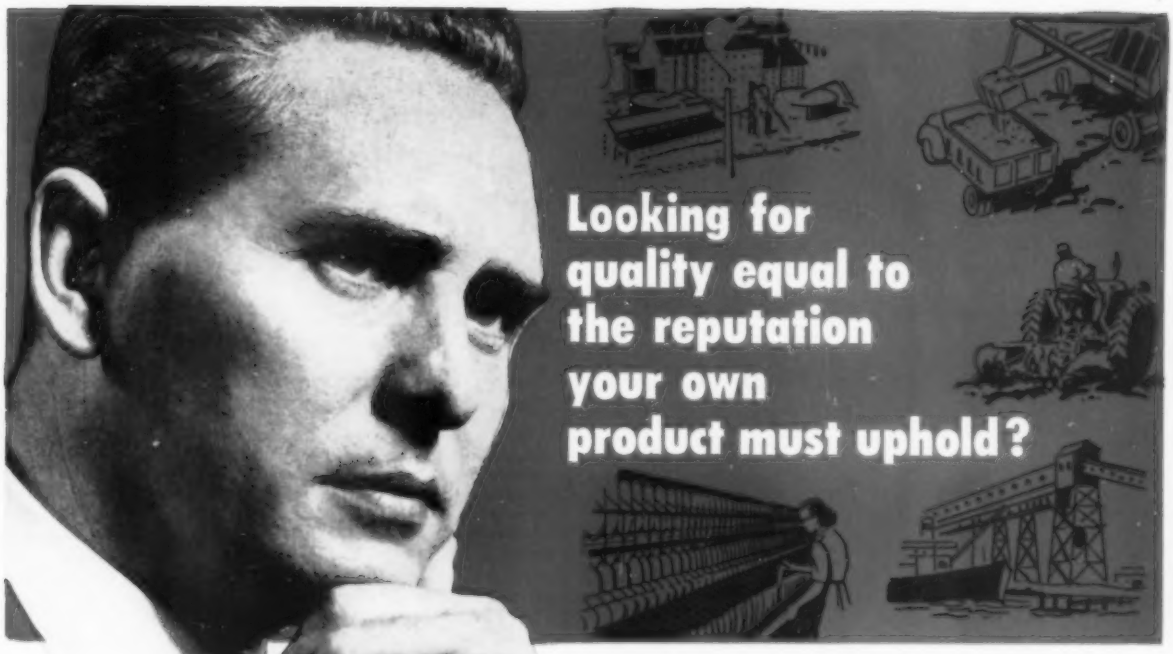
For your product development work, Indiana stocks a wide variety of standard Alnico V magnets—available immediately in experimental quantities. Write for Catalog 11-C6

THE INDIANA STEEL PRODUCTS COMPANY • VALPARAISO, INDIANA

World's largest manufacturer of permanent magnets

IN CANADA: The Indiana Steel Products Company of Canada Limited • Kitchener, Ontario

INDIANA PERMANENT MAGNETS



SEALMASTER'S

EXCLUSIVE COMBINATION OF FEATURES ASSURES NEW HIGH STANDARDS OF BEARING PERFORMANCE

Today, a designer who wants to get the most out of his product must look on components as part of his overall design. The fact that a bearing unit is just as essential to modern high performance and can cause failure of an otherwise perfectly engineered machine is reason enough for specific SEALMASTER recommendations. Each year as machinery gets faster, horsepower greater and manpower more costly, "downtime" becomes more critical.

No component you specify for the products you design or build will be of more dependable quality than SEALMASTER Ball Bearing Units. From design board to finished product SEALMASTER Bearings are the product of "Quality-minded" engineering and manufacturing processes backed by an exclusive combination of features. Find out today how important SEALMASTER Ball Bearing Units are to you!

Write today for your Free copy of SEALMASTER Catalog 454.

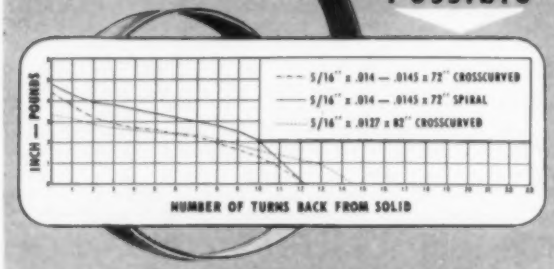
SEALMASTER
BALL BEARING UNITS

SEALMASTER BEARINGS, A DIVISION OF STEPHENS-ADAMSON MFG. CO. 9 RIDGEWAY AVENUE, AURORA, ILL.

Creative Papers from the mills of **Mosinee**

This CURVE

Makes This SANDSTEEL SPRING Performance CURVE Possible


INCH — POUNDS
5/16" x .014 — .0145 x 72" CROSSCURVED
5/16" x .014 — .0145 x 72" SPIRAL
5/16" x .0127 x 82" CROSSCURVED
NUMBER OF TURNS BACK FROM SOLID

Crosscurving is an exclusive Sandsteel spring-making process which gives a longer, more even release of energy. This super performance makes possible the use of longer, thinner springs to produce the consistent power required in many applications.

Only a superior metal can withstand the Sandsteel crosscurving process. It is given a convex structure along the length of the strip and a concave curve across its width. The spring is wound against the convex curvature in which it was tempered.

Section showing crosscurved spring in housing.

As a result, the spring delivers dual power . . .

1. It tends to spring back into the shape in which it was tempered
2. It releases reserve energy stored by the crosscurve which at full wind is partly flattened out.

When spring performance is important specify Sandsteel springs. Write for Free literature and case history files.

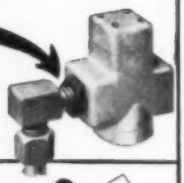
SANDVIK STEEL, INC.
SANDSTEEL SPRING DIVISION
Fair Lawn, New Jersey
Tel. Fair Lawn 4-6200
In New York: ALgonquin 5-2200

BB-123

TRU-O-SEAL
TEFLON SEAL

PAT. PENDING

STOPS PIPE THREAD LEAKS



Satisfaction Guaranteed Or Money Back TRIAL OFFER

TRU-O-SEAL Fittings are guaranteed to seal pipe thread connections permanently against all oils, practically all known chemicals and gases; to seal under high pressures or vacuum; to withstand —280° to plus 500° F.; to eliminate "overtightening" damage and pipe dope. Available in ⅛" to 2½" pipe thread sizes.

$10.00 Trial Offer No. 1: eight ⅛", ten ¼", eight ⅜", ten ½" pipe thread TRU-O-SEAL Fittings.

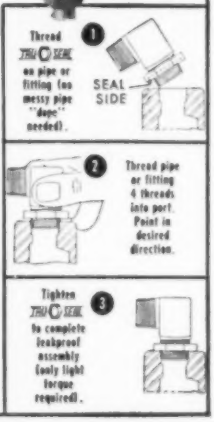
$10.00 Trial Offer No. 2: eight ½", ten ¾", four 1" pipe thread TRU-O-SEAL Fittings.

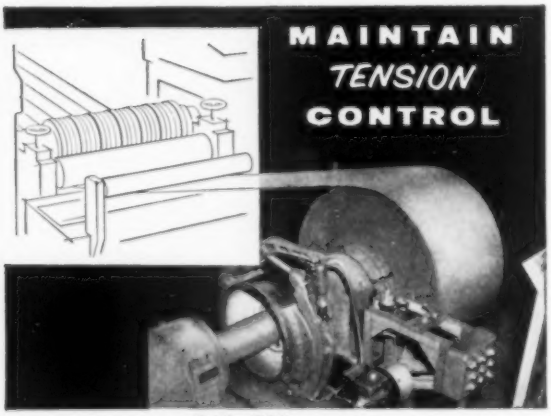
Send order to

TRU-O-SEAL DIVISION
Flick Reedy Corporation

2002-04 N. Hawthorne, Melrose Park, Ill.

"Miller Fluid Power" is also a Div. of Flick-Reedy Corp.


1
Thread TRU-O-SEAL on pipe or fitting (no messy pipe "dope" needed).
SEAL SIDE
2
Thread pipe or fitting 4 threads into port. Point in desired direction.
3
Tighten TRU-O-SEAL to complete leakproof assembly (only light torque required).



MAINTAIN *TENSION* CONTROL

with Wagner Actuating System and Brakes

Now, you can keep easily adjustable tension on heavy rolls used in steel slitting operations—in handling paper, and in other similar applications. Wagner Industrial Brakes maintain tension on the rolls and permit emergency machine stops, while Wagner Actuating Systems provide smooth, manually operated control. In the steel slitting machine installation shown above, a regulating valve is used to establish the amount of tension required for various materials and gage thicknesses. A hand operated application valve is used to apply or release the roll tension during set-up and operation.

Your nearby Wagner field engineer will develop detailed specifications to meet your special application. Call him today.

157-3

Wagner Electric Corporation
6406 PLYMOUTH AVE., ST. LOUIS 14, MO.

and stainless steel for 5000 psi. Other parts are stainless steel. The O-ring packing conforms to JIC hydraulic standards. Modrich Fluid Controls, Inc., 458 Virginia St., Crystal Lake, Ill.

For more information—
Circle 120, inside back cover

Miniature Solenoid Valve

The shutoff valve is 3/8 x 1 7/8 in. dia. It is available in 1/8 in. ips, is normally closed and features a spring-loaded plunger with soft seat for bubbletight shutoff, brass bar stock body and two-wire continuous duty solenoid.

The valve is said to be suitable for use with all common industrial fluids, including water, oil, gas and air at operating pressures up to 130 psi. General Controls Co., 801 Allen Ave., Glendale, Calif.

For more information—
Circle 121, inside back cover

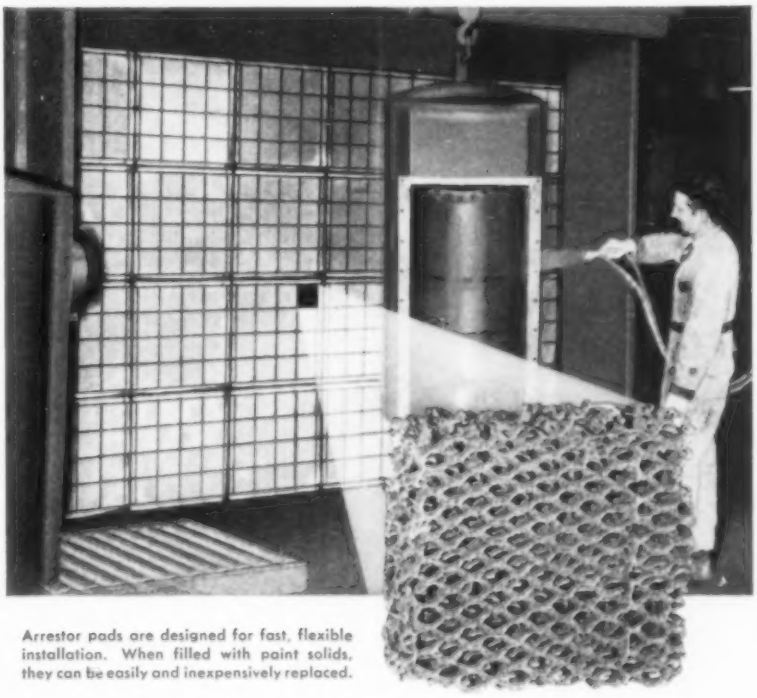
Double Solenoid Valve

A three-way double solenoid valve is available in three assemblies for mixing, divided flow and cylinder con-

(Continued on page 376)

Creative Papers from the mills of Mosinee

. . . are custom-tailored to specific needs . . . particularly yours



Arrestor pads are designed for fast, flexible installation. When filled with paint solids, they can be easily and inexpensively replaced.

Trapping dangerous paint spray with a honeycomb of paper

RESEARCH PRODUCTS CORP., Madison, Wisconsin, produces arrestors that trap non-used paint — both solids and volatiles — in paint spraying operations. Slit and expanded flame-resistant paper are used to fabricate these highly efficient arrestors. Sandwiched together, the sheets form thousands of tiny paint traps to protect both property and equipment.

This research-minded company knew just where to go for the paper to meet their specialized requirements —

MOSINEE! Perhaps there's a job that Mosinee sulphate paper can do equally well for you. If there is, there's no better way to discover it than by talking with a Mosinee consultant. And there's no time like the present for setting the wheels in motion by filling out and mailing this coupon.

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Please furnish details on how you can create special papers to meet our needs.

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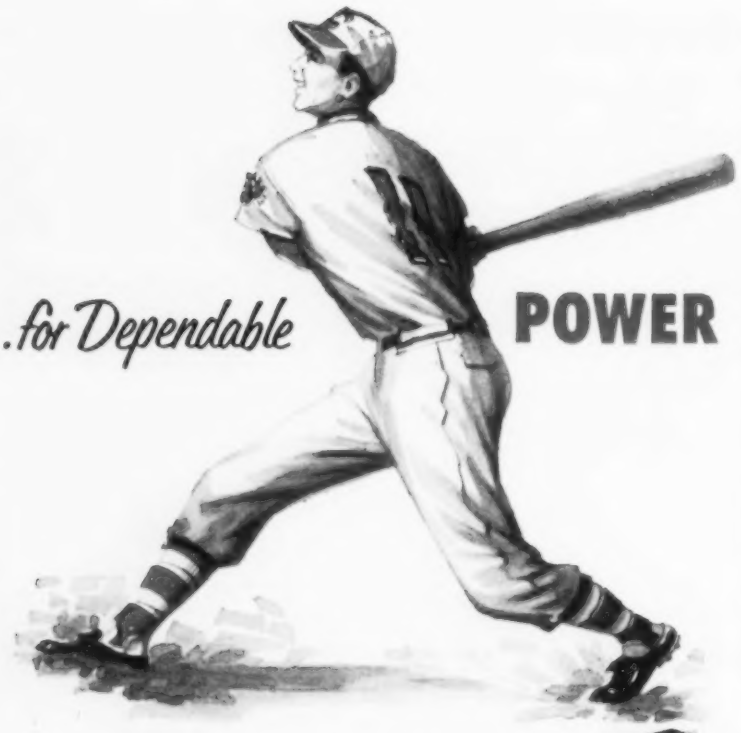

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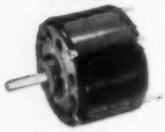
1/40 H. P. to 1/1100 H. P.

General Industries fractional hp. motors lead the league for dependability. No wonder most leading original equipment manufacturers specify GI for standard applications requiring ruggedness and economy! Call on the GI team for **free** design consultation service to help solve **your** fractional hp. problems.

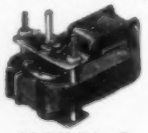
For **any** fractional hp. requirement—for prompt deliveries — **RELY ON GI!**

Write TODAY for complete specifications and quantity-price quotations!



MODEL B
4-pole, 4-coil shaded pole AC Induction Type

MODEL A
2-pole, shaded pole AC Induction Type

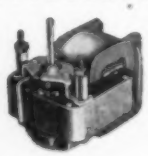


MODEL C
2-pole, shaded pole AC Induction Type

MODEL E
4-pole, shaded pole AC Induction Type

MODEL D
4-pole, 4-coil shaded pole AC Induction Type

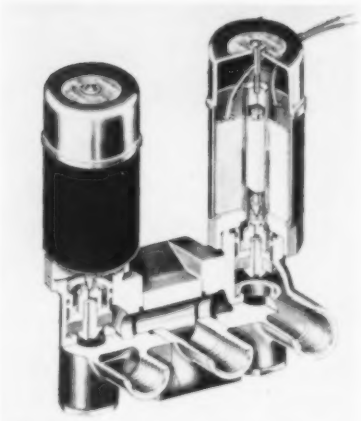
MODEL O
2-pole Capacitor Reversible Type AC only (for 6, 12, or 24 volts)



MODEL F
2-pole, shaded pole AC Induction Type

THE GENERAL INDUSTRIES CO.

DEPT GK • ELYRIA, OHIO



trol operations. The valve is said to bubbletight and may be used at specific pressures ranging from 5 to 1000 psi, with both pistons normally closed and at 5 to 500 psi with either or both pistons normally open. It is available in ½ and ¾ in. pipe sizes.

The valve may be used on air, water, oil or any fluid not harmful to Navy M bronze. Atkomatic Valve Co., Inc., 545 W. Abbott St., Indianapolis 25, Ind.

For more information—
Circle 122, inside back cover

ENGINEERING DEPT. EQUIPMENT

Resin-impregnated Tracing Paper

100% rag content tracing paper accepts pencil hardness up to 9H without tearing or puncturing, and it is said to erase cleanly and repeatedly without damage. Available in a 5 yd, 36-in. wide roll. Charles Bruning Co., Inc., 4700 Montrose Ave., Chicago 41, Ill.

For more information—
Circle 123, inside back cover

Oscillograph Record Viewer

The viewer has a motorized paper drive, a 16 x 18 in. backlighted viewing area, and will handle records of up to 16 in. wide and rolls up to 7½ in. dia.

The linear speed of the paper can

(Continued on page 379)

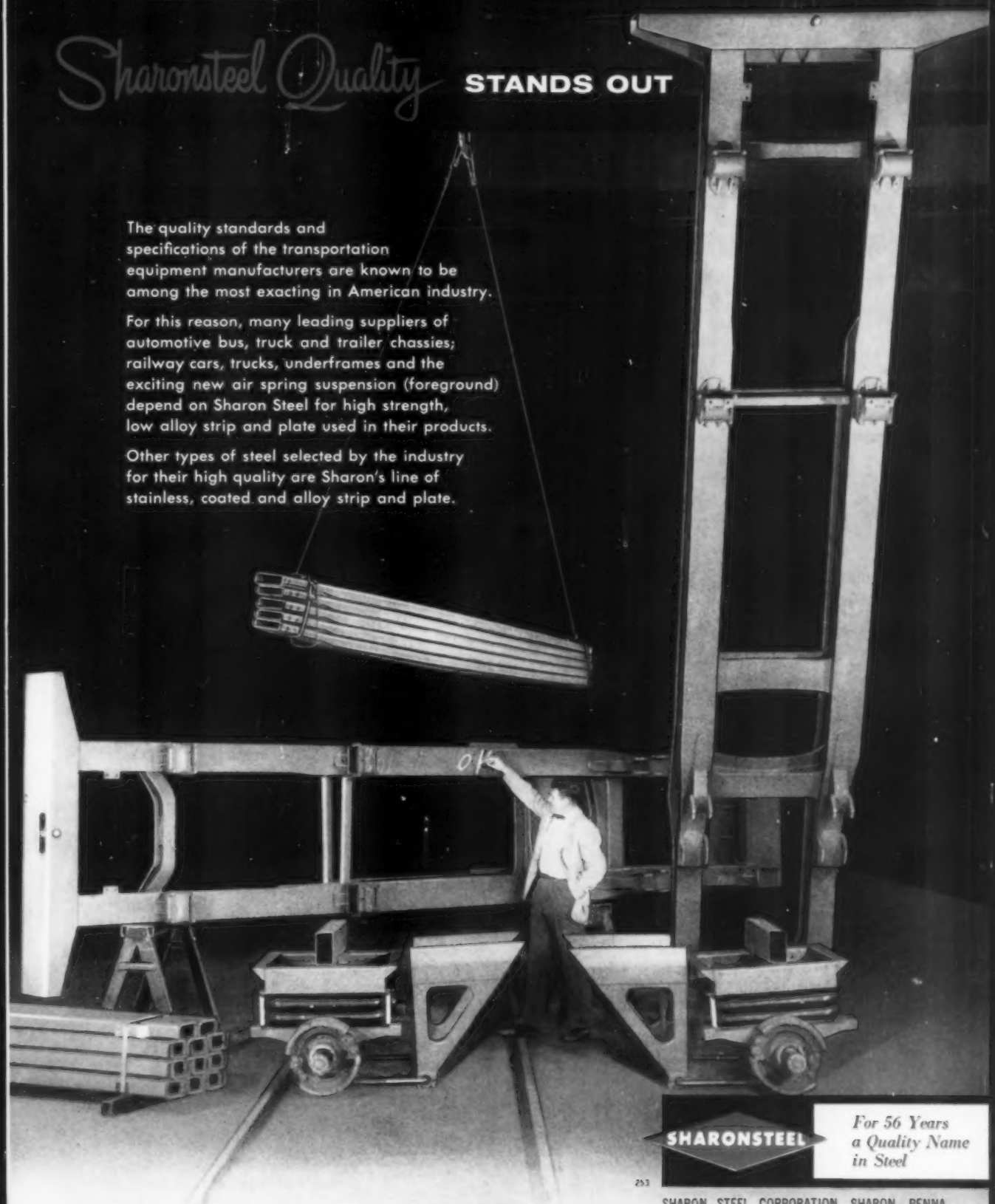
IN TRANSPORTATION EQUIPMENT, TOO

Sharonsteel Quality STANDS OUT

The quality standards and specifications of the transportation equipment manufacturers are known to be among the most exacting in American industry.

For this reason, many leading suppliers of automotive bus, truck and trailer chassies; railway cars, trucks, underframes and the exciting new air spring suspension (foreground) depend on Sharon Steel for high strength, low alloy strip and plate used in their products.

Other types of steel selected by the industry for their high quality are Sharon's line of stainless, coated and alloy strip and plate.



SHARONSTEEL

For 56 Years a Quality Name in Steel

253

SHARON STEEL CORPORATION, SHARON, PENNA.

CHICAGO, CINCINNATI, CLEVELAND, DAYTON, DETROIT, GRAND RAPIDS, INDIANAPOLIS, LOS ANGELES, MILWAUKEE, NEW YORK, PHILADELPHIA, ROCHESTER, SAN FRANCISCO, SHARON, MONTREAL, TORONTO

If your VACUUM or PRESSURE requirements are in this range

Vacuums to 27" Hg.
Pressures to 20 psig.
Displacement:
3.6 to 7.2 c.f.m.

. . . save space - - simplify mounting - - eliminate troubles - - improve operation

with

LEIMAN
Integral Rotary
AIR PUMP and MOTOR

MODEL K. 3.6 c.f.m. ½ hp.
13½" long - - 12" wide - - 7" high

MODEL K3. 7.2 c.f.m. ½ hp.
16" long - - 15" wide - - 9" high

- Steel wings for long wear
- Automatic Wing Adjuster
- Automatic oiler—requires filling only once in 60 to 80 hours.
- Ball bearings for quiet running
- Bearing grease cups need checking only once in 90 days
- Fan cooled—may be run 24 hours a day, 7 days a week
- Automatic thermal overload motor protection
- Noiseless operation
- Inlet filter and outlet separator
- Oil-free air

Automatic Wing Adjuster
Patented Leiman feature adjusts automatically, pushes steel wings into contact with cylinder wall, assures constant seal, prevents wings from sticking or binding.

Write for detailed folder and 12-page catalog showing many other Leiman pumps.

LEIMAN BROS, Inc.

107 Christie Street, Newark 5, New Jersey

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45,107 *Advertisements describe the products of* **11,859** *Advertisers*

Ametron® ELECTRONIC CRANE SCALES

Weighs heavy loads suspended from crane hook. Printer, located in crane cab or other convenient location, records weight on tape or cars. New compact printer only 22" x 18" x 10½".

Entire assembly designed for prompt and easy installation. Now available at new low cost. Capacities 5, 10, 15 tons.

Write for Free Ametron Brochure 13

STREETER-AMET COMPANY
GRAYSLAKE, ILLINOIS

THE STANDARD OF ACCURACY SINCE 1888

HOTWATT®
HEATING CARTRIDGES

FASTEST DELIVERY
IN THE INDUSTRY

Hotwatt's versatile production department allows rapid scheduling of heating cartridge orders whether big or small so that delivery is the fastest in the industry.

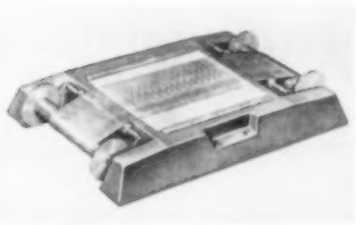
If your application requires quality heating cartridges and fast delivery schedules, it will pay to investigate Hotwatt. Also, the extensive line of PRECISION HEATING CARTRIDGES permits selection of a standard unit "custom designed" for your application.

Faster heating . . . higher heat density . . . and minimum heat loss in the core are other features of the line.

Stainless-steel units . . . other alloy units . . . or the low-cost ceramic body units are all available on the fast delivery schedule. At Hotwatt you receive precision heating cartridges . . . and delivery to meet your tight production needs.

Complete technical information is available upon request.

HOTWATT, INC.
ELECTRIC HEATING SPECIALISTS
16 Gould St., Danvers, Mass.



be varied by means of a foot pedal between zero and approximately 96 ips in either direction. A mechanical brake stops the record and maintains tension across the viewing area. Benson-Lehner Corp., 11930 Olympic Blvd., Los Angeles 64, Calif.

For more information—
Circle 124, inside back cover

Pocket Calculator

Made in Germany, this calculator is made of aluminum, weighing 1 oz with case and measuring 3 in. dia. It can be used for multiplication, division, percentages, areas, volumes, squares, cubes, conversions. Silver Bells, Ltd., 600-16 St., Oakland, Calif.

For more information—
Circle 125, inside back cover

Vernier Device for Setting Dividers

The silver-plated vernier scale provided on this divider setter made in England permits setting to 0.001 in.

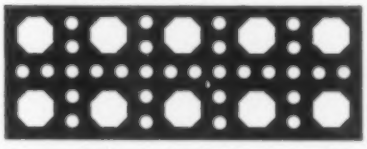
(Continued on page 383)

DIAMOND PERFORATED METALS

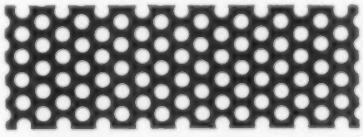
FOLLOW THE TREND

toward development of more attractive products through the greater use of DIAMOND ORNAMENTAL PERFORATED METALS.

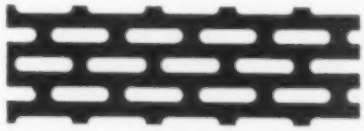
Perforated-Metal Sections supplied by Diamond to other manufacturers include **Grilles** and **Louvers,** for air conditioners, radios, juke boxes, television sets, automobile instruments, etc. Furnished also, for many modern products in **Rigidized Perforated Metal.**



Screens, for industrial processing, sterilizers, etc.; **Panels,** for space heaters, etc.; **Oil-Burner Chimneys; Perforated Cylinders,** for washing-machine and other centrifugal dryers; **Accoustical Sheet; Sound Baffles; Welded and Fabricated Assemblies** of all kinds.



Tooled for a great variety of perforations in any commercial metal, of any suitable thickness. **Geared** to meet the production schedules of America's leading industrial concerns—that's Diamond.



Want to know more about us and what we might do for you? Write for Catalogue No. 39.

DIAMOND MANUFACTURING CO.
Box 40 WYOMING (Wilkes-Barre Area) PENNA.

West Coast Plant, Diamond Perforated Metals Co.
17915 So. Figueroa St., Gardena, California
Los Angeles Area

UNICHROME
Trade Mark

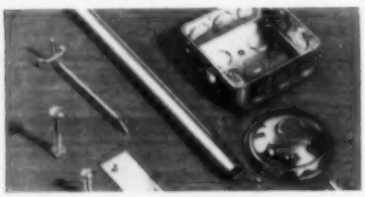
News about
COATINGS for METALS
Metallic.....Organic.....Decorative.....Protective

Plastisol gives metal products flexible armor against wear, corrosion

Chrome-like finishes produced at new low cost

For the first time, bright chrome-like finishes become economically practical for low cost zinc plated products such as electrical conduit and boxes, toy wheel goods, rough hardware and others. Economical chromate treating with newly developed Unichrome Dips is now being used to increase shelf life and sales appeal of even the most competitively priced products.

The new Unichrome Clear Dips operate at extreme dilutions. Make-



up costs are low. So are operating costs, even where dragout of solution during production is a factor. Costs for dip compound range between 30¢ and 60¢ per 1000 sq. ft. of surface treated.

A unique feature of these Dips is their stability, which saves through long "mileage" from the solutions, and consistent results.

Write Metal & Thermit for recommendation on your specific application. Virtually any requirement in chromate finishing can be met from the wide line of Unichrome Dip Compounds.

Unichrome is a trademark of Metal & Thermit Corp.

METAL & THERMIT
CORPORATION

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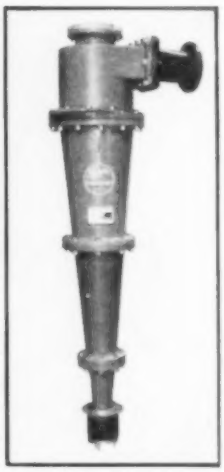
East Chicago • Los Angeles
In Canada: Metal & Thermit–United Chromium of Canada, Limited, Rexdale, Ont.



(Left) An example of the large work that can be protected, these metal cones for storage tanks are being sprayed by General Coating Co., Woodbridge, N.J., with "Super 5300" Plastisol for protection against abrasion and corrosion. **(Right)** Lined with Unichrome Plastisol, over 6000 of these centrifugal cleaners manufactured by Bauer Bros., Springfield, Ohio, are now defying wear and corrosion in paper mills.

Even ordinary metals protected with a coating of Unichrome Plastisol gain phenomenal ability to stand up in severe service. Engineers are finding in plastisols the means to improve product life, solve problems of wear and corrosion.

HEAVY DUTY MATERIALS

Sprayable Unichrome "Super 5300" Plastisol provides films up to 60 mils thick per coat. Unichrome "Series 4000" Plastisols form dipped coatings up to ¼-inch thick.

Unlike plastic sheet materials, plastisols conform to irregular shapes without air pockets or seams. The vinyl coating they form resists chemical solutions, fumes, moisture and other corrosives. Its pore-free thickness blocks permeation.

A Unichrome primer-plastisol system sticks tight, averaging a bond strength of 50 to 100 pounds per inch. It affords good flexibility to absorb mechanical abuse, resist abrasion to a remarkable degree.

SOME CASE HISTORIES

Liquid cyclones for removing dirt from pulp stock are subjected to abrasive, corrosive action of the stock. When made of stainless steel, bronze and chromium plated steel, they wore excessively. Lined with plastisol 4 years ago, these units have far exceeded life-expectancy of other materials.

Plastisol coated ducts exhausting strong acid fumes show no signs of deterioration after 4 years service.

Lining sand-blast barrels with Unichrome Plastisol increased barrel life twelve times for one user.

After six months use, plastisol coated agitators for chemical mixers show absolutely no wear. Rubber coatings, used previously, started to fail after only one month.

Write for detailed bulletins on Unichrome Plastisols or the name of the nearest applicator.

How T&W Technique is applied to serve the construction equipment industry better

If you are building construction equipment, investigate *T & W Technique* for producing forgings and deep drawn stampings. At the right are two examples of how a fully coordinated team of engineering and production facilities at T & W's Forging and Stamping Divisions serve industry better.

Send a sample or print of your part, today, for estimates.

SALES OFFICES | NEW YORK • PHILADELPHIA
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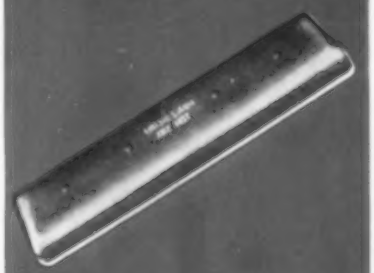
HOUSTON • LOS ANGELES

Forgings and Deep Drawn Stampings

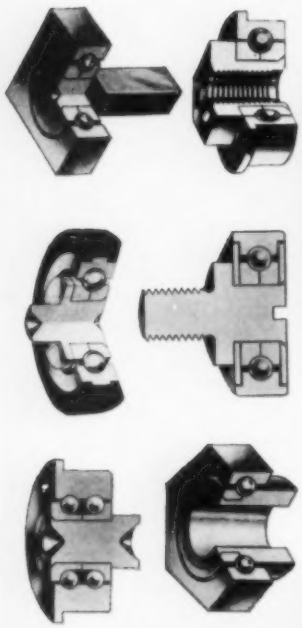
The valve cover produced in our Stamping Division measures 7⅜ inches wide, 36⅜ inches long, and 3⅜ inches deep. You can *depend* on T & W for your stamping requirements.



The double roller-type forging weighs 117 pounds; largest diameter 12 inches.

FORGINGS AND DEEP DRAWN STAMPINGS

TRANSUE & WILLIAMS
Over 50 years of experience
ALLIANCE, OHIO—USA



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Long life and service are assured you because —

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2. Each component part is properly heat treated.
3. Every Kilian Bearing is designed for a specific application.

Neoprene and Nylon tired outer races are available where quiet operation is desired.

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Available with resistance elements, thermocouple and thermistors

Flight speeds to Mach 5.0

Altitudes up to 10^4 feet

Temperatures up to 3200° R

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Flight and wind tunnel data available.

Aero Research INSTRUMENT COMPANY, INC.

Write for Bulletin 5

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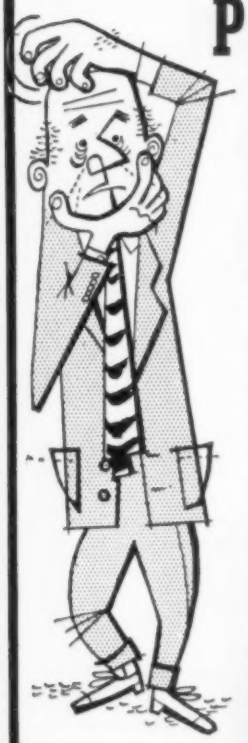

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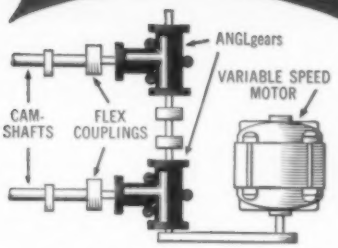
CHAGRIN FALLS, OHIO

ANGLgear solves timing problem



Drawing based on actual installation shows ANGLgear drives for camshafts on Herb-Shelly bagmaking machine. ANGLgears provide positive power transmission; assure correct timing of cam action.

A producer of polyethylene packaging, Herb-Shelly, Inc., Farmington, Minn., designs and builds much of its own production equipment.

One machine, an automatic bagmaker, required 90° power takeoffs to drive its two parallel camshafts. Chains and sprockets were rejected because even the slightest backlash would have affected timing. Miter gears were used instead. However, they failed repeatedly under the constantly fluctuating load imposed by the cams.

Finally, Herb-Shelly installed two standard ANGLgears. Result: the ANGLgears not only provided the positive, precision drive essential for accurate timing, but also, unlike previous bevel gears, had the stamina to absorb the continuous variations in load.

Perhaps ANGLgear can solve a similar 90° drive problem for you. ANGLgears are available from stock in 3 sizes; 12 models.

See our literature in Sweet's Product Design File; then contact your local distributor or write direct.

AIRBORNE®
AIRBORNE ACCESSORIES CORPORATION
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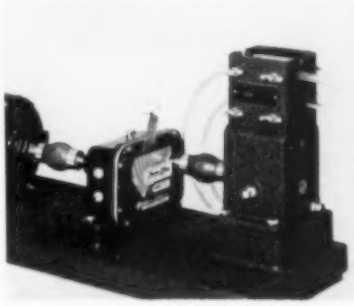
The Rule is Chromium Plated. Sold with case. Air Transport Equipment, Inc., Albany Ave., Amityville, N. Y.

For more information—
Circle 126, inside back cover



Small Volume or Laboratory Pump

Moving steel fingers provide a wavelike motion over flexible tubing to pump liquids, gases and slurries. This is said to eliminate any possibility of contamination of the liquid being pumped, or corrosion of the pump.

The pump accommodates tubes of ¼, $\frac{5}{16}$, ⅜, $\frac{1}{16}$ in. ID, $\frac{1}{16}$ in. wall; and $\frac{3}{32}$ in. ID, $\frac{3}{32}$ in. wall. Gum rubber, silicone rubber, surgical gum latex, neoprene or polyvinyl tubes are satisfactory.

Capacity is 0.1 cc to 250 cc per min. The standard unit includes a speed changer and a ½ hp. motor with switch, mounted on an aluminum base. Sigmamotor, Inc., 31 N. Main St., Middleport, N. Y.

For more information—
Circle 127, inside back cover

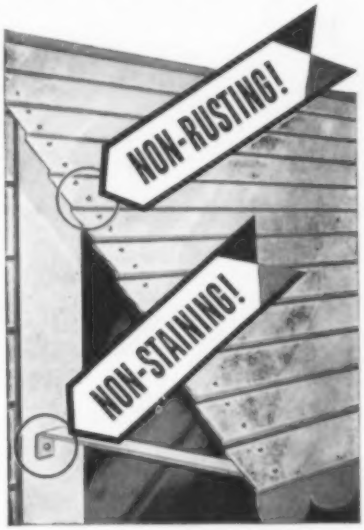
Powered Pencil Pointer

A Pencil Pointer is designed to point any drawing instrument from pencil to beam compass with any type of point desired, whether needle sharp or flat. It has a built-in wiping pad.

Only one hand is needed for the

(Continued on page 387)

How Alcoa Aluminum Fasteners make good awnings even better



Alcoa® Aluminum Fasteners guard your reputation for quality aluminum awnings. They insure against both galvanic and atmospheric corrosion. They provide perfect color match and lasting good looks. Specify Alcoa Fasteners for assembly and installation. Your local Alcoa distributor carries complete stocks for every requirement. He is listed in the Yellow Pages of your telephone directory.

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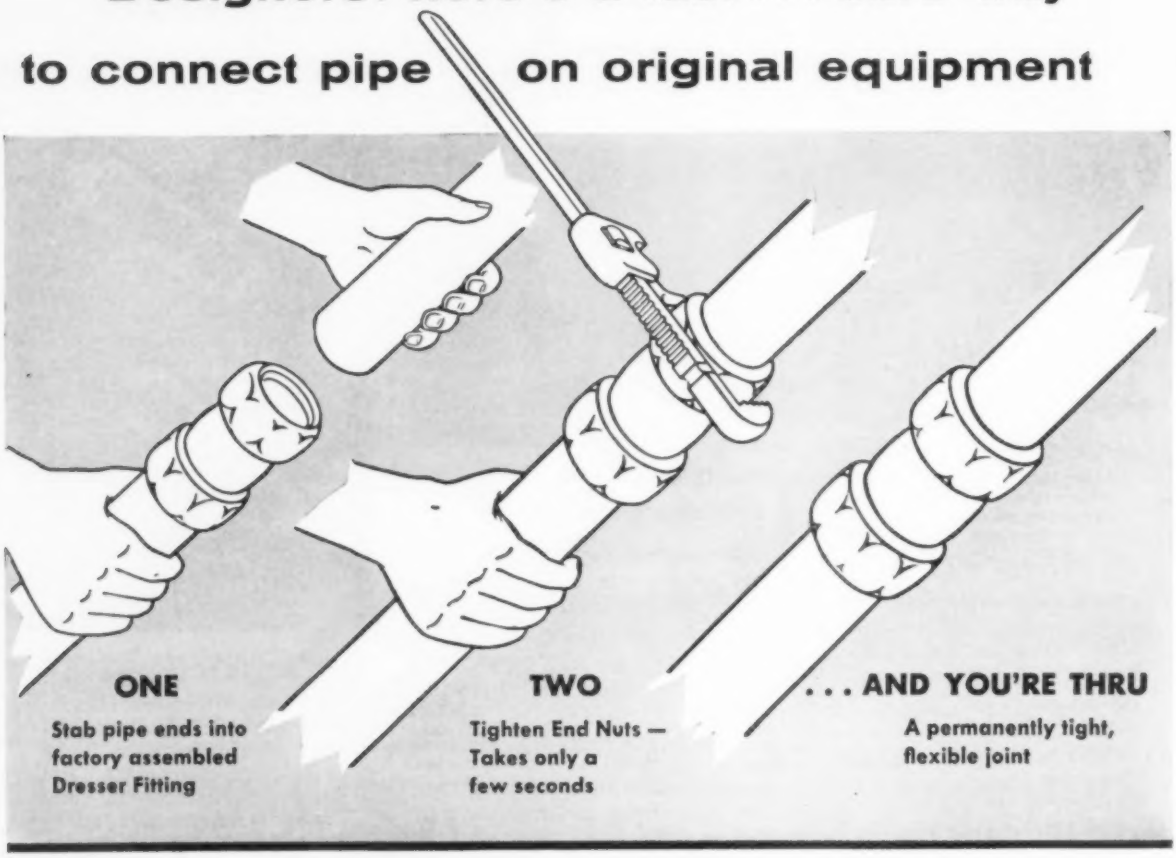
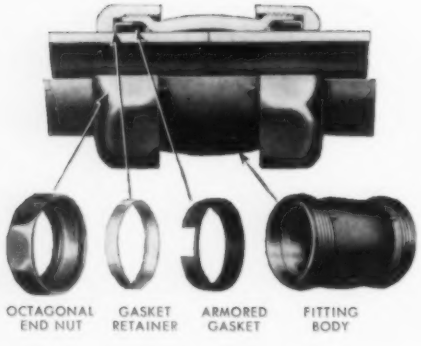
Designers: here's a fast . . . sure way to connect pipe on original equipment


ONE
Stab pipe ends into factory assembled Dresser Fitting
TWO
Tighten End Nuts — Takes only a few seconds
. . . AND YOU'RE THRU
A permanently tight, flexible joint

DRESSER flexible compression fittings



No threading . . . No complicated pipe fitting!

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- Supports
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A SUBSIDIARY OF MINNESOTA MINING AND MANUFACTURING COMPANY

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ELCO SEMS The "Sems" method of pre-assembled screws and washers is used by ELCO to produce cost-reducing units of many kinds. Stock SEMS are made up of standard screws and washers — *special* SEMS can be designed, engineered, and produced to order as required. Let us quote on your standard requirements — send us your prints on specials. *Write for free package of samples.*

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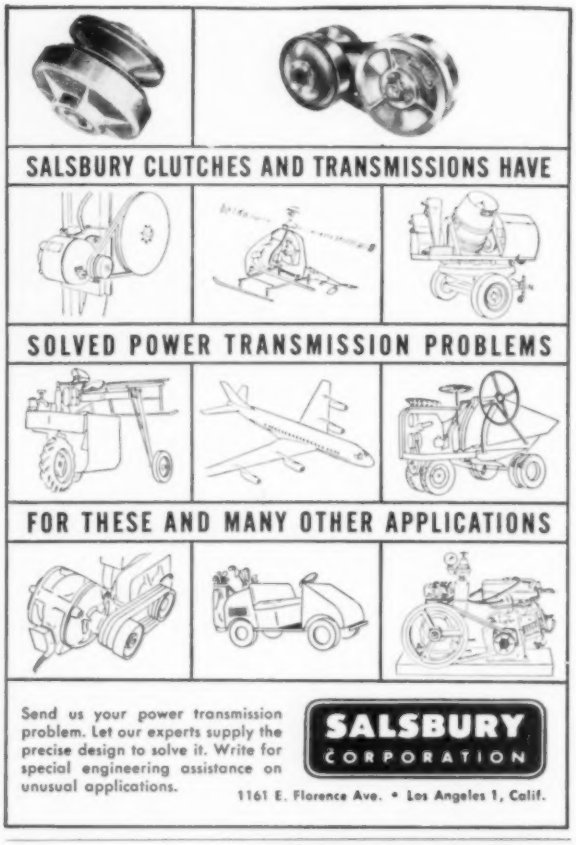

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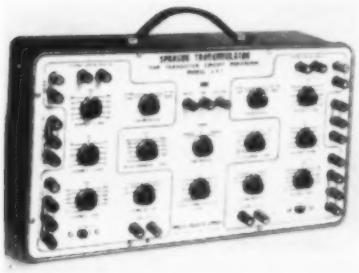
complete operation. Opening the lid starts the motor, which vibrates the filing plate used for sharpening lead. Closing the lid shuts off the motor. Filings collect in base.

The plastic case is available in six attractive colors. Motor is of shaded pole design. Ferance Construction Co., Penfield, N. Y.

For more information—
Circle 128, inside back cover



Transistor Circuit Simulator

An instrument is said to eliminate breadboard layout by simulating complete transistorized amplifier stages. Any a-c or direct-coupled amplifier stage short of high power audio output can be simulated, as can multivibrator, switching, phasing, push-pull, Class A and B circuits, and others. Common or grounded emitter, base, or collector circuits may be simulated using PNP, NPN, or surface barrier transistors. Sprague Products Co., 195 Marshall St., N. Adams, Mass.

For more information—
Circle 129, inside back cover

Method for Verbal Transmission of Graphic Information

The system consists of a uniform sheet of graph paper with a series of dots evenly spaced in a square or rectangle. This particular paper has 169 dots in 13 vertical and 13 horizontal lines. The 13 x 13 dot system gives a field of spaces 12 x 12 permitting the transmission of information based on the metric system as well as on the English system. The 12 x 12 spaces permit the user to divide the field easily into fractions while the 13 dots provide for a center point and the

(Continued on page 389)

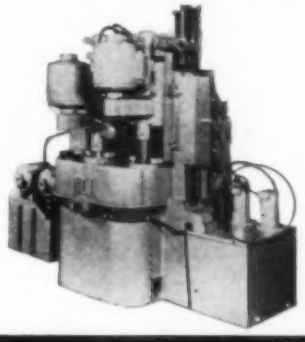
CONNECT THEM . . . FORGET THEM . . .

Ruthman Gusher COOLANT PUMPS

REQUIRE LITTLE MAINTENANCE

Ordinarily Gusher Coolant Pumps require no attention. Because there are no packing glands to adjust and they are equipped with heavy duty prelubricated for life, ball bearings. Your maintenance worries are minimized when you specify Gusher Pumps. **Write for our Catalog.**

THERE'S A GUSHER FOR EVERY REQUIREMENT



Illustrated is a Springfield Dual Spindle Vertical Grinder equipped with Gusher Coolant Pumps.

Model 6-P3 Immersed Type

Ruthman MACHINERY CO.

1818 Reading Rd., Cincinnati, Ohio

- COOLANT PUMPS
- CIRCULATORS • AGITATORS
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The TIMER RELAY that handles all controlled timing problems . . .

- ★ No false contacts
- ★ Non sticking
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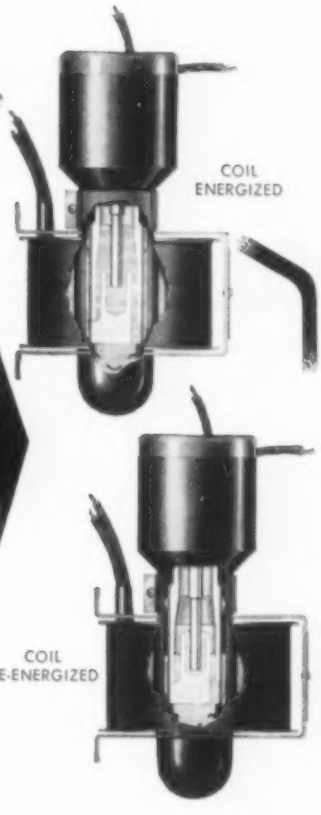
Durakool®
STEEL MERCURY TIMERS



COIL ENERGIZED

COIL DE-ENERGIZED

This steel clad, factory set, tamper proof Durakool timer-relay is practically non-breakable. Operating life multiplied 5 to 6 times by new plunger construction features. Combinations of operate-release time delays from 0.15 sec. to 20 sec.—either normally open or normally closed action.

See telephone directory for local distributor, or write.

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ELKHART, INDIANA, U.S.A.
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INDUSTRIAL
RETAINING RINGS

SERIES 3100

External rings (NAS 51) applied axially to shafts.

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Internal rings (NAS 50) applied axially into housings.

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Open-type rings applied radially to shafts. Series 1000 rings may be ordered stacked for easy one-at-a-time dispensing.

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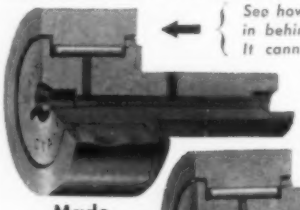
Originators of modern retaining ring dispensing

a COMPLETE LINE of
ROLLER BEARINGS & CAM FOLLOWERS
Can Be Made To Fit The Need With Any Size Stud Required

Because the flange that holds the roller is a part of the stud itself, the STUD DIAMETER can be made up to 100% greater in relation to the size of the roller as shown below.

REGULAR—TYPE CTA



See how the Snap Ring fits in behind the solid flange. It cannot be pushed out.

HEAVY DUTY TYPE HCS

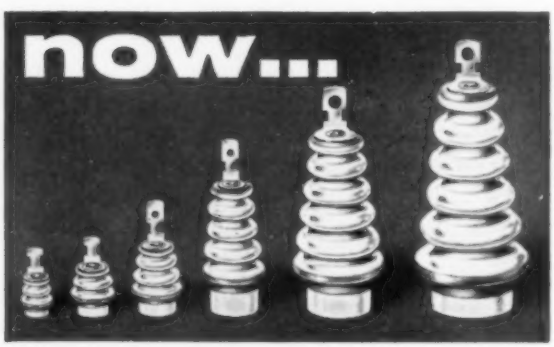
Made Exclusively by SMITH
Same Price for Either One

Maintenance and replacement costs are greatly reduced by the patented snap ring feature. High Capacity has large diameter stud EXCLUSIVE with Smith. Cam Yoke and Standard Cam Follower interchangeable with other lines.

Ask our Distributor or Home Office for NEW Engineering Bulletin No. 103

Bulletin Lists Names and Addresses of All Distributors

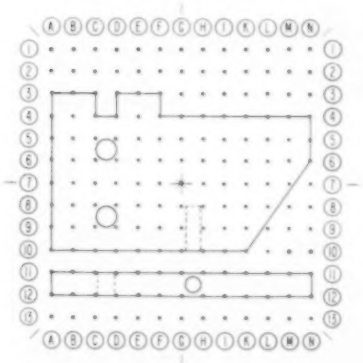
THE SMITH BEARING CO., INC.
STATION A, P. O. BOX 1119 • TRENTON, N. J.



Frenchtown Metallized Terminals!

Here is Frenchtown's improved line of Annuluted Type NICOTE Metallized Hermetic Terminals for use in controls, relays, transformers, capacitors, motors, and heater units. Custom-engineered of HIGH ALUMINA CERAMICS and metallized with our exclusive NICOTE, these terminals are available in six varying sizes with a choice of terminal hardware to fit any exacting application. Write for Engineering Bulletin 1055.

frenchtown PORCELAIN COMPANY
87 Muirhead Avenue | Trenton 9, New Jersey



division of the year into four quarters, one sheet representing one quarter (or 13 weeks). Provision has been made for rapid location of the center point, center lines and diagonals.

By assigning any desired scale to the ordinate and abscissa of a blank sheet and indicating the location of the points to the called party in a telephone connection, the calling party can transmit graphic information of many types. Illustration is of a jig plate, drawn from verbal instruction. Robert Marx, 83-02 Talbot St., Kew Gardens 15, Queens, N. Y.

For more information—
Circle 130, inside back cover

Pocket Lead Pointer

This lead pointer accommodates all types of standard refill leads and pencil leads. It contains four tempered steel blades, interlocked to assure smooth, tapered points. Alvin & Co., Inc., Windsor, Conn.

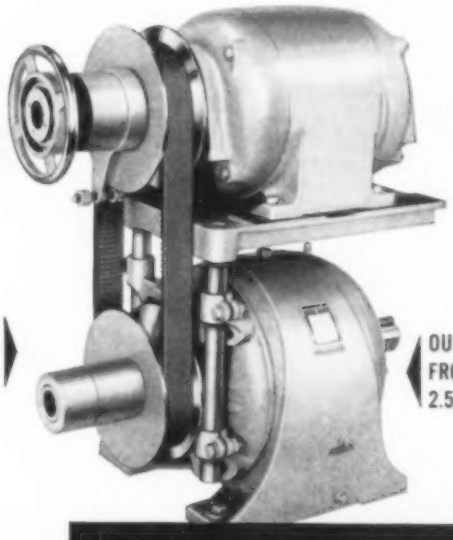
For more information—
Circle 131, inside back cover

Clamp-On Shelf

This shelf is clamped on drawing board, desk, work table or bench. Keeps drawing instruments, small tools or reference material within easy reach. The device locks perfectly level

(Continued on page 393)

NEW FOOTE BROS.
Vari-Mount REDUCER



INCLUDES LEWELLEN
VARIABLE PULLEYS

- Lewellen Variable Pulleys directly connect, and variably power the drive.
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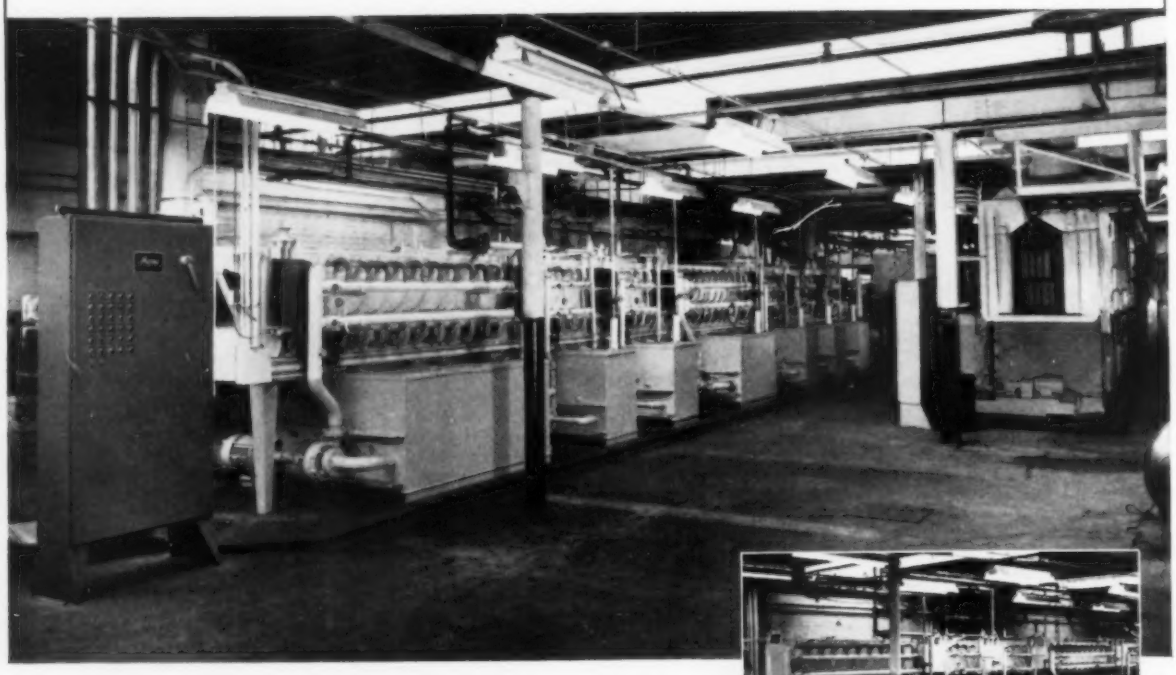
First in the Nation



1. 75-foot continuous treatment strip machine, left, and automatic Spra Bonderite, right, in Parker's new customer service lab.

Now, for the first time in the industry, Parker Rust Proof Company brings you a way to test surface treatment of metals on a production line basis, *before* you install surface treatment equipment in your plant.

You can save time, trouble and money by making use of the extensive research facilities of Parker's unique new customer service laboratory. It's a research lab with production line equipment, run like a production line.

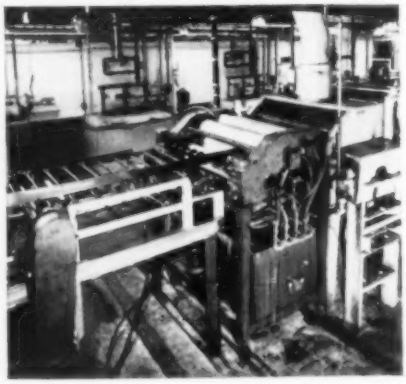
This automated lab can treat sample stock by the ton. It is equipped to prepare samples and conduct tests involving all of Parker's varied and outstanding surface treatments of metals.

If you have a metal surface treatment problem, you are cordially invited to make use of this new testing service. Just contact your nearest Parker representative, or write or call Parker Rust Proof Company.

PARKER
RUST PROOF COMPANY
2179 E. MILWAUKEE, DETROIT 11, MICHIGAN

Since 1914—leader in the field

2. Tons of steel in coils await treatment in the strip and sheet treating machine.



3. Bonderlube is applied over Bonderite treatment for cold forming sample. Roller coating section at end of strip machine is interchangeable.

STAINLESS STEEL MAKES THE DIFFERENCE

...its effect on modern appliance design

Make it more attractive – longer-lasting – easier to keep clean. And keep it simple to make. More and more designers "build in" such powerful selling points with stainless steel.

Stainless keeps pace with modern trends. Now there are more than 30 different types and a variety of textures, surface tones and colors. The hard-selling values of superior corrosion resistance, durability and toughness, long associated with stainless give you assurance of consumer acceptance at the point-of-sale.

For more facts about stainless steel and the contribution it can make to your product or marketing problems, see your stainless steel supplier or write ELECTROMET – leading producer of more than 100 alloys for the metal industries, including chromium and manganese used for making stainless steel. Ask for the booklet "Stainless Steel in Product Design." Write ELECTRO METALLURGICAL COMPANY, Division of Union Carbide Corporation, 30 E. 42nd Street, New York 17, N. Y. *In Canada:* Electro Metallurgical Company, Division of Union Carbide Canada Limited, Toronto.

METALS DO MORE ALL THE TIME ... THANKS TO ALLOYS

Stainless steel styling adds the attractive, durable, "easy-to-clean" appeal which is helping to put across this new idea in cooking units.

Electromet
FERRO-ALLOYS AND METALS

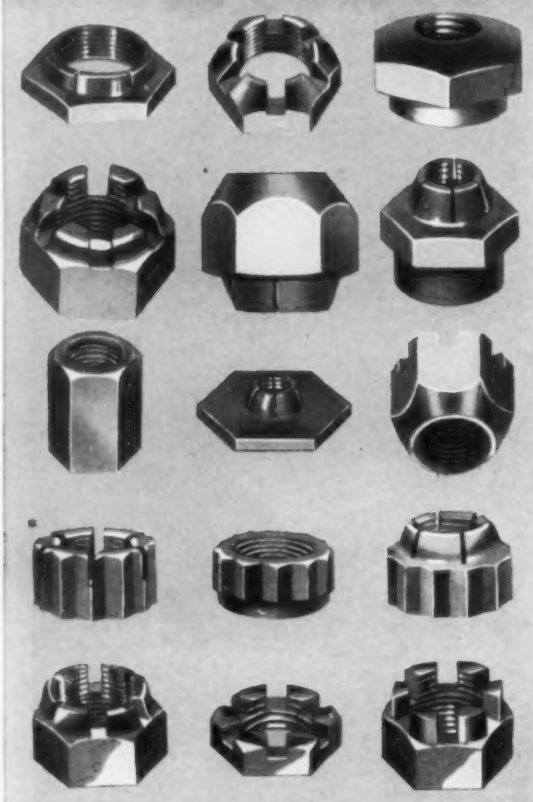
UNION CARBIDE

The terms "Electromet" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

SPECIAL NUTS

to specs. 7/16" - 4-1/4" cross flats

special machines + large stock of material x years of experience = speedy deliveries high quality low prices



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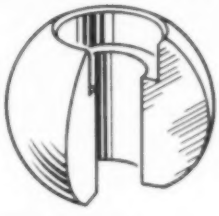

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Circle 133, inside back cover

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CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 405.

Computations for Metal Working–Bulletin 38, 50 pp. Contains information and alignment diagrams for computing pressure and sustained work capacity of presses, as well as pressure and work requirements of the job the press is to do. It provides formulas and charts on blanking and shearing, drawing and reducing; ironing; coining, sizing and forging, and extrusion.

Another section contains helpful information on selecting the proper press for the work to be done, and discusses the important factors to be considered. There are also tables on properties of metals, sheet metal and wire gages and approximate diameters of blanks for shells. E. W. Bliss Co., 1375 Raff Road, S. W., Canton, Ohio

Circle 134, inside back cover

Steel Balls–Catalog, 12 pp. Contains data on balls of special materials such as high-nickel or cobalt-base alloys, tool steel, plastics, nylons and vacuum-melted materials. New Departure, Div. General Motors Corp., Bristol, Conn.

Circle 135, inside back cover

Teflon–Handbook, 20 pp. Contains chemical, thermal, electrical and ageing properties as well as modern methods in handling Teflon. TA Mfg. Corp., 4607 Alger St., Los Angeles 39, Calif.

Circle 136, inside back cover

Snap Couplings–Bulletin 270, 2 pp. Describes quick-connect, quick-disconnect unit. Snap-Tite, Inc., Union City, Pa.

Circle 137, inside back cover

Boron Stainless Steel–Bulletin, 8 pp. Contains data on chemical composition, structure, mechanical properties, and thermal neutron absorption of plate, sheet, strip and bars. Superior Steel Corp., Carnegie, Pa.

Circle 138, inside back cover

Teflon Wire and Cable–Catalog, 30 pp. Contains data and prices on Teflon and silicone-insulated magnet wires, lead wires, and tubing. American Super-Temperature Wires, Inc., W. Canal St., Winooski, Vt.

Circle 139, inside back cover

Hydraulic Cylinders–Bulletin 5768, 10 pp. Provides information on the construction and features of 2000 psi units, including trunnion-mounted cylinders. Vickers Inc., Detroit 32, Mich.

Circle 140, inside back cover

Retaining Rings–Catalog, 20 pp. Contains data on gapless, two-turn, coil action units. Thompson Products, Inc., St. Louis, Mo.

Circle 141, inside back cover

Fhp Centrifugal Pumps–Bulletin, 8 pp. Contains diagrams and data on units in five sizes from ¾ to 2 in. The Corley Co., Inc., 103 E. Main St., Plainville, Conn.

Circle 142, inside back cover

Mechanical Packings–Brochure P325, 8 pp. Contains data on pressures, dimensions and mechanical requirements of units for solvent, acid, corrosive or alkali. Crane Packing Co., Dept. PEN, 6400 Oakton St., Morton Grove, Ill.

Circle 143, inside back cover

Plugs, Jacks and Connectors–Brochure, 8 pp. Contains data on standard and miniature units. Richards Electrocraft, Inc., 3739 N. Kedgie Ave., Chicago 18, Ill.

Circle 144, inside back cover

Custom Molded Parts–Brochure, 6 pp. Contains information on parts plus resistance chart of PVC. Tube Turns Plastics, Inc., 2929 Magazine St., Louisville 11, Ky.

Circle 145, inside back cover

Magnetic Disk Brake–Data sheet, 2 pp. Contains data and diagrams on unit for hazardous locations. Dings Brakes, Inc., 4740 W. Electric Ave., Milwaukee 46, Wisc.

Circle, 146, inside back cover

Stainless Steel Bar and Wire–Booklet, 24 pp. Describes 45 types of stainless steel, including several special proprietary grades. Armco Steel Corp., Middletown, Ohio

Circle 147, inside back cover

Thermistors–Catalog, 10 pp. Gives specifications and characteristics of Wafer, rod and bead units. Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J.

Circle 148, inside back cover

Plastic Laminate For Printed Circuits–Booklet B-6577, 8 pp. Discusses what printed circuits are, their advantages, and the construction and properties of plastic laminate. Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.

Circle 149, inside back cover

Welded Bellows–Brochure, 4 pp. Contains data, diagrams and charts of units in stainless steel and similar alloys. Belfab Corp., 11 Ramah Circle, Agawam, Mass.

Circle 150, inside back cover

Plastic Valves and Pipe Fittings–Bulletin, 16 pp. Describes PVC units designed for piping systems where piping corrosive fluids present a problem. Walworth Co., 60 E. 42 St., New York, N. Y.

Circle 151, inside back cover

Speed Reducers–Bulletin CD218, 24 pp. Discusses the use of double-enveloping worm gearing. Michigan Tool Co., 7171 E McNichols Road, Detroit 12, Mich.

Circle 152, inside back cover

V-Belts–Bulletin 20X6234C, 12 pp. Describes various types of V-belts and tells how to select and match them. Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.

Circle 153, inside back cover

Aircraft Components–Catalog 101, 88 pp. Contains data on pressure hoses with detachable reusable fittings for air, water, fuel, lube and hydraulic applications. Also provides answers to fluid line problems encountered by designers, and supplies data on bend radii of hoses, installation tech-

(Continued on page 431)

MOLY NEWS

CLIMAX MOLYBDENUM COMPANY, 500 FIFTH AVENUE, NEW YORK 36, N. Y.

Super-Strength Structural Steels Boost Minimum Yield Strengths to 150,000 psi.

Seven steel companies in the U. S. are now producing a group of "Super-Strength Structural Steels" with considerably higher yield strengths than the well-known "High-Strength Low-Alloy" steels.

These Super-Strength steels offer minimum yield strengths ranging from 55,000 to 150,000 psi. And they have other useful properties, depending on composition, including strength at moderate temperatures, toughness at low temperatures, and good wear resistance. Almost all of these steels contain molybdenum as an essential element.

The search for steels with greater yield strengths has gone on for many years. Before about 1930, carbon steels with a yield point of roughly 30,000 psi were standard for almost all structural purposes. Then came the development of "High-Strength Low-Alloy" steels. They boosted minimum yields into the 50,000 psi range.

Now, the newer Super-Strength Structural Steels are being welcomed by designers, who see in them a way to solve one of their major problems — to minimize weight and size while retaining quality and reliability.

. . . For more information on these steels, including their trade names and compositions, circle number 1 on the coupon.

Moly's High Hot Strength Shows Promise for Jets and Rockets

Molybdenum-base alloys were described at the 1955 American Rocket Society annual meeting as having the greatest promise for true high-temperature operation.

Missile and powerplant designers are interested in moly mainly for its high temperature strength. Molybdenum-base alloys have been developed with higher useful strength at temperatures over 1600 F than any other presently known metallic material.

The jet propulsion field — including guided missiles and aircraft powered by rocket, ramjet, and turbojet engines — covers a tremendous variety of requirements and service conditions in respect to temperature, atmosphere, amount and type of stress, vibration, thermal shock, and prospective life. Molybdenum's properties make it a logical choice in many cases because it has:

1. High creep and rupture strength.
2. High tensile strength at high temperatures.
3. High modulus of elasticity.
4. A combination of high thermal conductivity, low specific heat, and low expansivity, which minimizes nonuniform temperature distribution and makes molybdenum insensitive to thermal shock.
5. High resistance to erosion by hot gases.
6. High melting point.

It seems safe to conclude that molybdenum-base alloys will become important structural materials in the jet propulsion field. And they will become essential for many parts operating at temperatures in excess of 1600 F.

. . . from "Molybdenum for High strength at High Temperatures," by R. Freeman and J. Briggs, JET PROPULSION, *February, 1957.*

For a copy of the complete article, circle number 2 on the coupon.

Moly Adds Strength and Corrosion Resistance to Titanium

Commercially pure titanium is fairly strong and highly corrosion-resistant. Alloying it, however, substantially increases these useful properties.

Molybdenum may prove to be one of the most useful of the alloying elements for titanium. Studies at Armour Research Foundation, for example, show that when molybdenum is used instead of vanadium, creep properties are greatly improved. At 1020 F, a stress of approximately 20,000 psi produces a creep rate of 10^{-4} in. per in. per hr in Ti-6 Al and Ti-6 Al-4 V, whereas 40,000 psi is required to produce the same creep rate in a Ti-7 Al-3 Mo alloy.

In summary, new alloy development is opening the way for titanium's extensive use in jet engines and air frames. Ti-Al-Mo alloys, for example, give better elevated temperature properties than the Ti-6 Al-4 V alloy now most widely used. And the alloy containing 7% Al and 3% Mo appears particularly promising.

Another Ti-Mo alloy contains 30 to 40% Mo. This alloy is claimed to resist boiling 40% sulphuric acid and boiling 20% hydrochloric acid as well as platinum, tantalum or gold. Such a retained beta alloy is weldable and could be fabricated into sheet. These corrosion-resistant characteristics would add to the value of all-beta Ti-Mo alloys.

. . . from "Molybdenum as an Alloy Addition for Titanium," by Harold Margolin, METAL PROGRESS, *February, 1957.*

For a copy of the complete article, circle number 3 on the coupon.

Moly Goes to Sea In A Sewer

Cast iron joint ring in pipe, before lowering into position. Joint rings were made by Alhambra Foundry Co., Ltd. and the concrete pipes poured by American Pipe and Construction Co.

Positioning 64 ton reinforced concrete sewer pipe sections puts quite a strain on the cast iron joint rings used to join them. Especially when the job is done under water at depths up to 210 feet.

Joint rings must be strong enough to withstand stresses developed when the pipe is drawn together, plus sufficient impact resistance to withstand handling and placement.

Those are good reasons why the County Sanitation District No. 2 of Los Angeles County specifies ASTM A 48, class 40 iron for the rings. In addition to the required 40,000 psi, tensile strength, and 2600 lb transverse strength minimum, (on a 1.2 in. test bar), the bar must be capable of deflecting at least 0.20 in. and the iron must contain at least 0.40% Cr, 0.60% Cu and 0.35% Mo.

Examination of pipe lengths after six years' service showed them in excellent condition. Equally good performance is expected from the most recent installations which extend some 8000 feet into the Pacific Ocean, and are believed to be among the largest in the country.

. . . For more information on the contribution of moly to toughness and shock resistance of cast iron, circle number 4 on the coupon.

Climax Molybdenum Company, Dept. 61,
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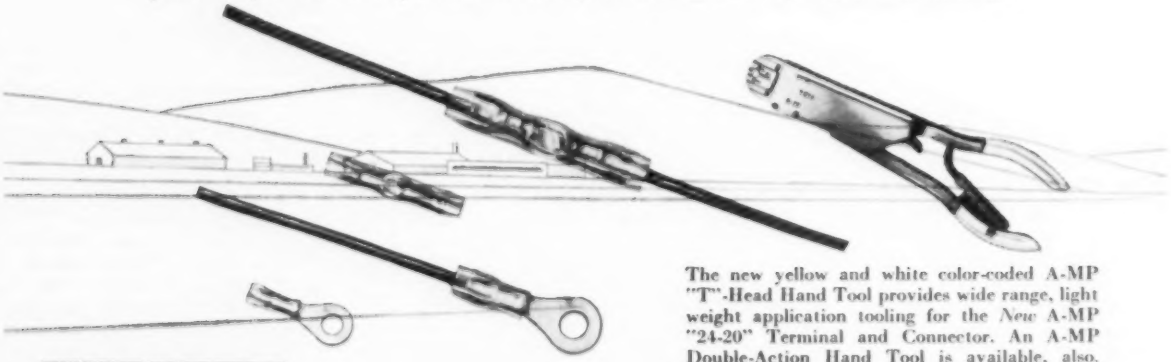
The *New* A-MP "24-20" Terminal and Connectors are designed expressly to resist *vibration, shock and similar stresses* encountered in wire applications in every industry. They retain all of the excellent features of the A-MP Pre-Insulated Diamond Grip line, with special emphasis on the need for weight and space savings so important in today's equipment design.

Features of the *New* A-MP "24-20" Terminal and Connector are:

- Designed to accommodate smaller insulation diameters of new wire specifications.
- Nylon insulated for the many favorable advantages provided by this reliable synthetic material.
- Miniaturized for space and weight savings.
- The unique design of the terminal's tongue area affords maximum utilization of the metal's inherent structural characteristics.



The new yellow and white color-coded A-MP "T"-Head Hand Tool provides wide range, light weight application tooling for the *New* A-MP "24-20" Terminal and Connector. An A-MP Double-Action Hand Tool is available, also. Both tools feature the A-MP Certi-Crimp® Control . . . for positive crimping of the terminal to the wire.

Additional information is available on request.

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Distributor in Japan: Oriental Terminal Products Co., Ltd., Tokyo, Japan

niques, and assembly procedures. Aeroquip Corp., 300 S. East Ave., Jackson, Mich.

Circle 154, inside back cover

Magnet Wire Trade Name Directory—Booklet, 16 pp. This directory, in addition to listing the various trade names, gives a brief general description of the physical, chemical and electrical characteristics and applications common to the ten general classifications of magnet wire. Essex Wire Corp., Fort Wayne, Ind.

Circle 155, inside back cover

Stainless Tubing and Pipe—Bulletin, 4 pp. Describes 17-7 alloy in tubular form. Carpenter Steel Co., Union, N. J.

Circle 156, inside back cover

Industrial Colloidal Dispersions—Chart, 4 pp. Lists 44 colloidal and semi-colloidal dispersions of graphite, molybdenum disulfide, mica, vermiculite, zinc oxide, acetylene black, copper and glass. Acheson Colloids Co., Port Huron, Mich.

Circle 157, inside back cover

Worm Motor—Brochure, 1 pp. Contains data on unit for powering small electric appliances. Brevel Products Corp., 601 W. 26 St., New York 1, N. Y.

Circle 158, inside back cover

Marine Hoses and Fittings—Catalog 301, 54 pp. Contains data on flexible piping for marine applications including information on bend radii, pressure and vacuum, and fittings for use with diesel fuel, lube oil and hydraulic fluid. Aeroquip Corp., 300 S. East Ave., Jackson, Mich.

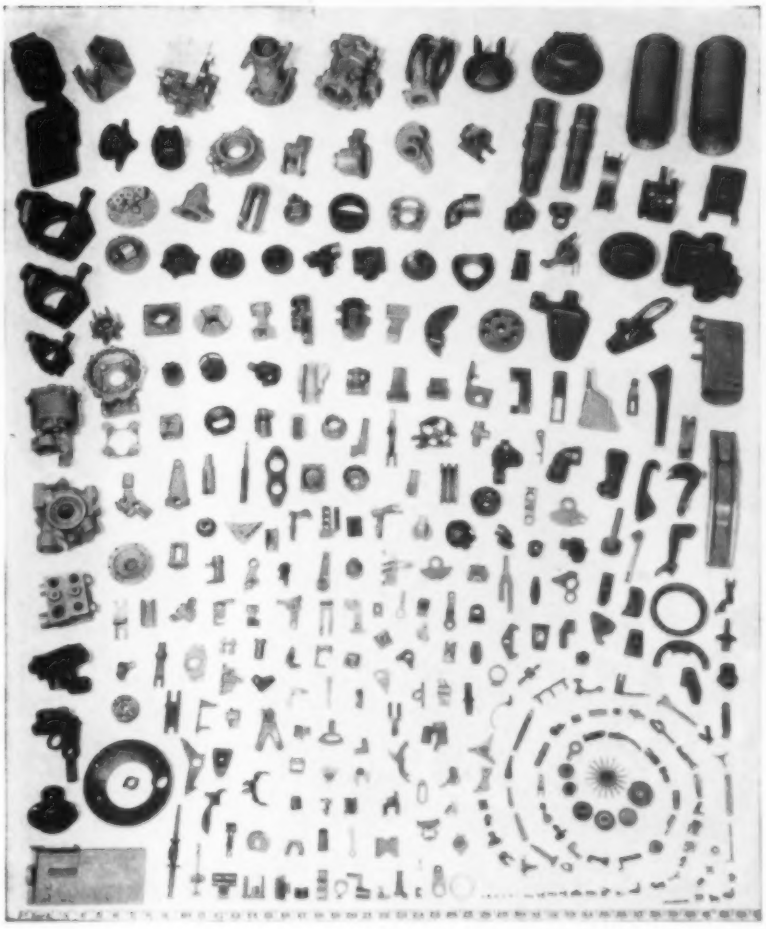
Circle 159, inside back cover

Stainless Steel Fastenings—Catalog 56A, 24 pp. Lists over 7,000 items including knurled and drilled parts, special threading, cross-drilled parts, double-end milled parts, dowel pins, tapered and grooved parts, captive screws, and headed parts. Star Stainless Screw Co., 655 Union Blvd., Paterson 2, N. J.

Circle 160, inside back cover

Small Metal Parts—Catalog 21, 44 pp. Contains diagrams and data on an assortment of standard lugs, clips,

(Continued on page 401)



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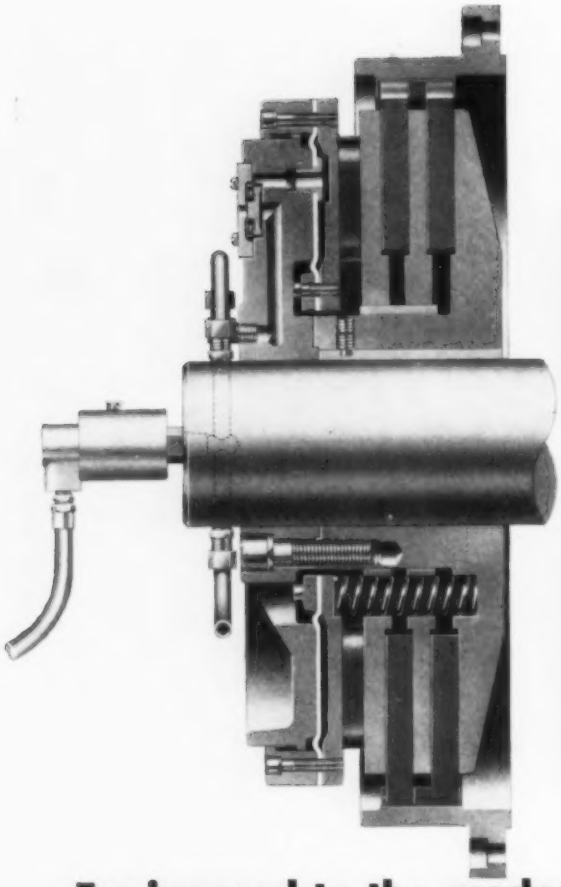

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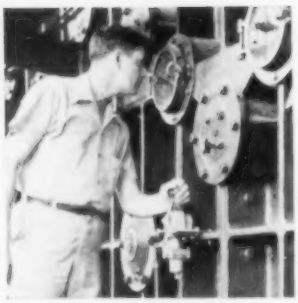

Finger tips on the throttle bring instant response, give the operator split-second control. This new product of Dodge is the quickest-acting air clutch available!

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The unique design of the Air-Grip Clutch places the air seal disc at the end *farthest* from the pressure plates, which generate the heat inherent in clutch operation. This, combined with automatic internal ventilation, insures cooler operation and longer life under severest service. Provision is made for mechanical engagement of the clutch if the air supply should fail.

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terminals, and wire forms. Zierick Mfg. Corp., Beechwood Ave., New Rochelle, N. Y.

Circle 161, inside back cover

Chains–Catalog, 8 pp. Describes conveyor, elevator, power transmission and several new chain developments. Moline Malleable Iron Co., St. Charles, Ill.

Circle 162, inside back cover

Corrosion-Resistant Fittings–Catalog, 21 pp. Contains diagram and data on elbows, flanges, gaskets, reducers and connectors. Horace T. Potts Co., Erie Ave. and D St., Philadelphia 34, Pa.

Circle 163, inside back cover

Electromechanical Breadboard Parts–Catalog, 24 pp. Contains diagrams and data on grid plates, component hangars, couplings, shafting, limit stops, dial assemblies, gears and differentials, ball and disc integrators and magnetic clutches. Helipot Corp., Newport Beach, Calif.

Circle 164, inside back cover

Galvanic Protection–Manual, 40 pp. Describes the use and application of zinc as a galvanic anode to protect iron and steel from corrosion. American Zinc Institute, Inc., 60 E. 42 St., New York 17, N. Y.

Circle 165, inside back cover

Glass–Brochure EPFF-1, 4 pp. Gives information on the four types of glass. Corning Glass Works, Corning, N. Y.

Circle 166, inside back cover

Die-Cast and Molded Parts–Bulletin, 9 pp. Lists 67 different types of zinc alloy die-cast and thermoplastic molded products. Gries Reproducer Corp., 125 Beechwood Ave., New Rochelle, N. Y.

Circle 167, inside back cover

Zirconium and Hafnium–Booklet, 12 pp. Describes uses, mechanical and physical properties, and sodium process for producing these metals. U. S. Industrial Chemicals Co., 99 Park Ave., New York 16, N. Y.

Circle 168, inside back cover

Magnetic Relays–Brochure, 8 pp. Contains data on a-c–d-c units for applications requiring additional coil power and increased relay contact actuating force. Essex Wire Corp., Fort Wayne, Ind.

Circle 169, inside back cover

Aluminum Mill Products–Brochure, 18 pp. Contains selection guides for wrought alloys in sheet, plate and foil, wire rod and bar, tubing and pipe, extruded and structural shapes, and casting alloys. Reynolds Metals Co., 2500 S. 3 St., Louisville 1, Ky.

Circle 170, inside back cover

Voltage Regulators–Data file. Contains diagrams and charts on silicon regulators. Transitron Electronic Corp., Wakefield, Mass.

Circle 171, inside back cover

Pump Valves–Bulletin, 8 pp. Describes unit which incorporates a taper-lock stud, self-locking nut and drop-on guard. Durabla Mfg. Co., 114 Liberty St., N. Y. 6, N. Y.

Circle 172, inside back cover

Temperature Measurement and Control–Bulletin, 4 pp. Contains data on resistance elements for control. Arthur C. Ruge Associates, Inc., 733 Concord Ave., Cambridge 38, Mass.

Circle 173, inside back cover

Silicon–Booklet, 20 pp. Discusses relation of silicon and its properties to electronics industry. Aries Laboratories, Inc., 41 E. 42 St., New York 17, N. Y.

Circle 174, inside back cover

A-c Motor–Bulletin, 1 p. Contains data on 900 frame unit. Induction Motors Corp., 570 Main St., Westbury, N. Y.

Circel 175, inside back cover

Fine Resistance Wire–Bulletin 157, 12 pp. Gives data on the electrical and physical properties of resistance alloys in diameters as small as 0.00045 in., with resistance of 3951 ohms per ft at 68 F. Driver-Harris Co., Harrison, N. J.

Circle 176, inside back cover

Clutches and Brakes–Bulletin, 6 pp. Contains data on magnetic units from 2 to 13 in. O.D. Fawick Corp., 9919 Clinton Road, Cleveland 11, Ohio.

Circle 177, inside back cover

Electrical and Pyrometer Controls–Catalog, 16 pp. Describes automatic packaged controls, suitable for indus-

(Continued on page 402)

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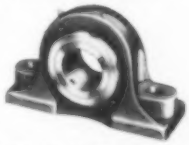

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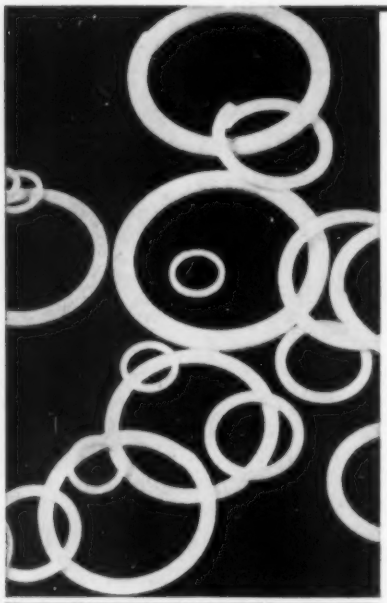

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trial application where a chemical or mechanical function can be measured electrically. Tipp-Tronic, Inc., Tipp City, Ohio.

Circle 178, inside back cover

Relays—Catalog, 14 pp. Contains data on electronic flashers, time delay relays, sequence timers, over and under voltage and frequency sensors and voltage regulators. Electronic Specialty Co., 5121 San Fernando Road, Los Angeles 39, Calif.

Circle 179, inside back cover

Extruded Tubing—Brochure, 2 pp. Contains data on Teflon tubing with temperatures range from —90 to 250 C. L. Frank Markel and Sons, Norristown, Pa.

Circle 180, inside back cover

Heat Exchangers—Bulletin, 4 pp. Contains diagrams and data on exchangers for combustion engines, compressors, turbines. Whitlock Mfg. Co., W. Hartford 10, Conn.

Circle 181, inside back cover

Hoses, Assemblies and Fittings—Catalog, 8 pp. Contains diagrams and

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charts on vinyl plastic units for pressures up to 125 psi. Hofmann Engineering Co., 5601 S. Crawford Ave., Chicago 29, Ill.

Circle 182, inside back cover

Carbon, Alloy and Stainless Steels–Folder, TDC 138, 2 pp. Two tables are shown. One lists dimensional data for 16 sizes of pipe from ¼ to 8 in. The other covers ASTM, ASME specifications. Babcock & Wilcox Co., Beaver Falls, Pa.

Circle 183, inside back cover

Laminated Pipe–Bulletin, 4 pp. Contains data and applications of chemically inert, fracture-proof pipe processed from Teflon resin and glass fiber. Resistoflex Corp., Roseland, N. J.

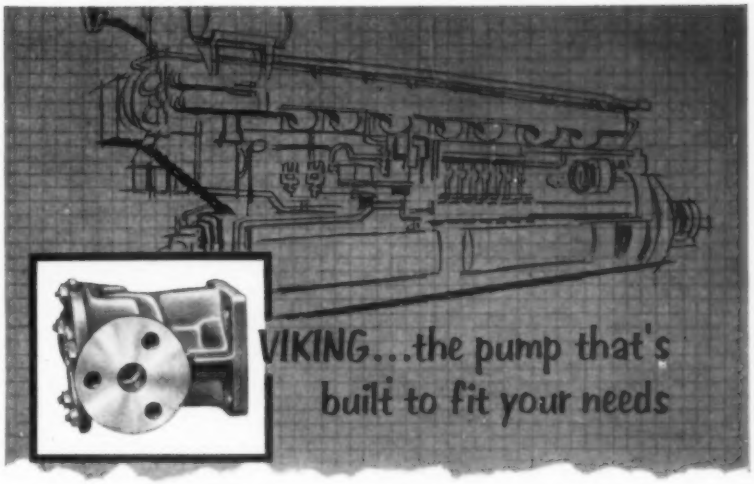
Circle 184, inside back cover

Control Transformer–Brochure, 4 pp. Describes normal reactance-type unit for applications from 115 to 575 v. Hindle Transformer Co. Inc., Woods Church Road, Flemington, N. J.

Circle 185, inside back cover

Pushbutton Switches–Data sheets (2) 124, 125. 1 p. each. Contains information on alternate action and

(Continued on page 405)



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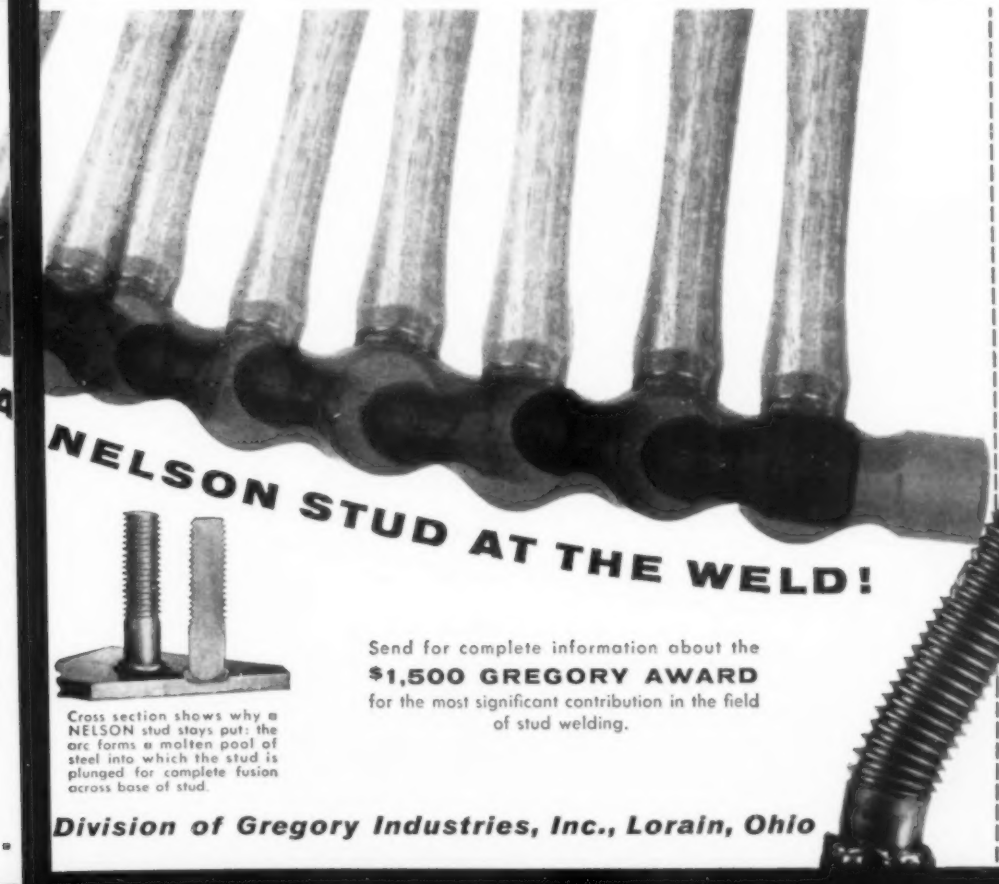

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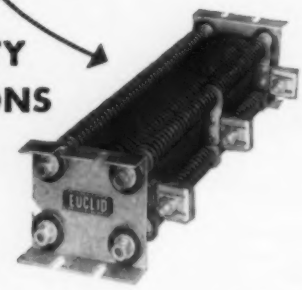

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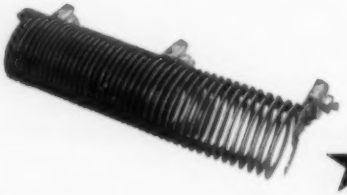
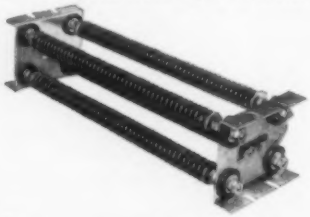
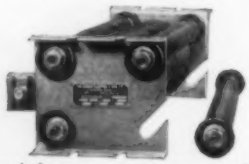


Continuous stainless steel edge-wound coil without joints eliminates hot spots, buckling and distortion.



Support rods on outside of coil permit unobstructed cooling air flow and compact design for smaller size and less weight per horsepower.

Exclusive slotted design



Slotted end frames permit removal and replacement of coil without disturbing rod assembly.

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2756 No. 33rd ST., MILWAUKEE 45, WIS.

"typewriter" units. Micro Switch, Freeport, Ill.

Circle 186, inside back cover

Lubrication Fittings–Catalog 38-23, 32 pp. Contains diagrams and data on fittings, bushings, elbow bodies, fitting extensions, plugs, tools, couplers and nozzles. Stewart-Warner Corp., 1826 Diversey Pkwy., Chicago 14, Ill.

Circle 187, inside back cover

Aluminum Aircraft Castings–Bulletin, 6 pp. Contains data on alloys 356S and 356T. American Brake Shoe Co., 230 Park Ave., New York, N. Y.

Circle 188, inside back cover

Titanium Pipe and Tubing–Bulletin TDC 185, 12 pp. Discusses seamless titanium pipe and tubing. Babcock & Wilcox Co., Beaver Falls, Pa.

Circle 189, inside back cover

Flexible Hose Assemblies–Catalog 101, 4 pp. Contains diagrams and data on Teflon hose. Mic-Lin Co., Maple Shade 6, N. J.

Circle 190, inside back cover

Temperature Regulators–Bulletin, 4 pp. Contains data on self-operating units for regulating steam to control temperature. Cash Standard Stacon Corp., P. O. Box 551, Decatur, Ill.

Circle 191, inside back cover

Studs–Booklet, 24 pp. Discusses stud selection, counterbore and countersink dimensions for accommodating weld fillets, recommended thicknesses of steel on which studs are welded, and stud locating procedures including template design. Gregory Industries, Inc., Lorain, Ohio.

Circle 192, inside back cover

Worm Gear Drives–Bulletin 145, 16 pp. Contains information on speed reducers and worm gear sets. Cleveland Worm & Gear Co., 3249 E. 80 St., Cleveland 4, Ohio.

Circe 193, inside back cover

Letterhead Requests Only

Manufacturers who publish following literature ask that requests for copies be made on company letterheads.

Electromagnetic Control – Catalog 57-S, 170 pp. Contains diagrams, charts and information on automatic transfer switches, remote control switches, magnetically held contactors, relays, a-c and d-c solenoids and electric plant controls. Automatic Switch Co., 50-56 Hanover Rd., Florham Park, N. J.

American Standard for Semi-Tubular Rivets–5 pp. Contains tentative draft for Sectional Committee B18 on the standardization of bolts, nuts, rivets, screws and similar fasteners for criticism and comment. ASME, 29 W. 39 St., New York 18, N. Y.

Casters–Catalog 20, 75 pp. Contains data on units for household, office and instituutional furniture and miscellaneous equipment. Faultless Caster Corp., Evansville 7, Ind.

Epoxy Resins–Booklet, 22 pp. Discusses epoxy resin compounds designed for the electrical and electronics industry. Features tabulation of physical and electrical properties for nine different potting resins, as well as graphs of properties of more than 40 different compounds and curing agents. The Epoxylite Corp., 10829 E. Central Ave., El Monte, Calif.

Aluminum Bus Conductor–Handbook, 280 pp. Contains 69 graphs, tables and photographs discussing the development of aluminum's use and its properties as a conductor. Chapters deal with conductor shapes, design, reactance, capacities, deflections, joints and short-circuit conditions, and installation. Alcoa, 793 Alcoa Bldg., Pittsburgh 19, Pa.

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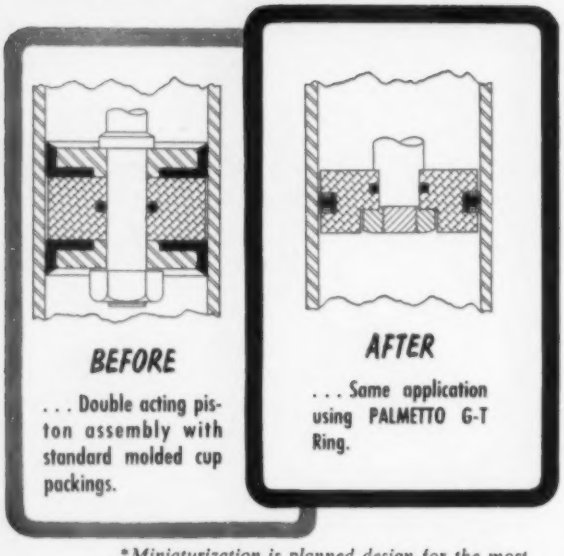

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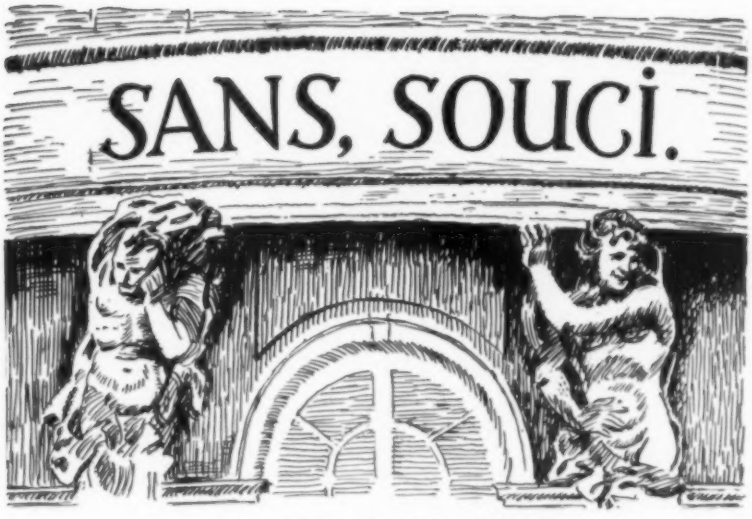


Ad Libbing by The Editor

Shortly after a fighter pilot had "gotten his wings," his captain gave him a test to find out how well the new pilot could follow another plane at night. On a clear dark night, with many stars and only a few small clouds in the sky, the captain took off in his Mustang followed by the lieutenant.

The lieutenant had no trouble following the bright taillight of the plane ahead of him. The lieutenant kept chasing the light ahead, but finally it seemed to be keeping on a straight path for an unusually long time.

Finally it dawned upon the young pilot that he was not chasing the taillight of his captain's plane but that he was aiming straight for a bright fixed star, a star perhaps a thousand light years away. His captain had purposely lost him.

On the face of it, chasing after a star is a rather futile thing to do. One can never hope to reach it.

In spite of all the seeming futility of it, figuratively, everyone should pick a star to chase. That star should be a bright objective sitting in a clean, clear field of glory. "Star differs from star in glory," but the star chosen must be one that is compatible with the interests and hence the abilities of the chooser. Where lie the interests, there also lie the abilities.

Too many people permit the promise of high income or social distinction to decide for them the star that is to be their goal. Charlie's wife was socially ambitious and therefore prevailed on Charlie to become an office worker instead of the farmer he wanted to be. Charlie never amounted to much as an office man but his flower garden and beautiful shrubbery were the "talk of the town."

Vernon Holbert had to leave grade school to help support his family. He got a job in a printing shop, worked hard, learned much and progressed fast. He learned his trade as an art, treated it as an art and loved it. But he also became intensely interested in teaching and the bright star that he selected to aim at was to become a great teacher of the art of printing. A man who never finished grade school, to become a teacher? By hard study and much night school, Vernon Holbert obtained his New York State teacher's certificate. For about 28 years, he taught printing in one of the Brooklyn high schools. He was recently retired. Today he is happy, his family and friends are justly proud of his accomplishments and his fellow teachers honored him upon his retirement. Measured by every yardstick, his life was a great success. He had selected a bright star, suited to his abilities.

Men choose the ministry or teaching for their life work in spite of the fact that both those professions are notoriously underpaid. Yet there have been teachers and ministers, many of them, who received handsome returns for their efforts. As Dr. Russell pointed out in his famous "Acres of Diamonds" speech, material wealth is to be found in your own back yard, rather than in the distant fields. And "your own back yard" is nothing more than your own native abilities, interests and ambitions. It is the place from which you see your great star shining brightly.

Young people find it extremely difficult to select the star which is to be their objective. Those that do find it often happen to do so solely by accident. Many people are virtually pushed into undertaking the job for which they are best suited. Circumstances over which they have no control have forced many people to enter the field of work best suited for them; where otherwise they would have refused to undertake it. It was just such a situation that impelled me to join the editorial staff of PRODUCT ENGINEERING, at the time that it was launched.

In the more than 27 years since that day when I found my star and started my journey toward it, the air was often bumpy, the direction of progress sometimes had to be corrected a little to get back on the beam, sometimes the going was slow and sometimes fast. But the aim was always in the direction of that bright star so far away, and yet seemingly so near. Of course, I never reached it.

The time has come for another man to take over the task of navigating and operating this editorial ship and to betake the title of editor. After this issue in which I present this, my last "Sans, Souci," the title of editor of PRODUCT ENGINEERING goes to Mr. Elmer Tangerman. This transfer of title will cause no commotion whatsoever because in fact, Mr. Tangerman has been doing all the work of the chief editor for the past six months.

In retiring from editorial work and responsibility, I find a great deal of satisfaction. Through my work I gained a host of friends and acquaintances, learned much about the trials and tribulations of the design engineers, watched the development of many new components and products and enjoyed the writing of editorials and "Sans, Souci." It was my good fortune to be the editor of PRODUCT ENGINEERING during its growth from babyhood to the publication that it is.

No—I never reached my star. It is still there, bright and high in the heavens. I wish that I might have come closer to it. I did not get there, but it sure was fun going. To those editors who come after, my best wishes for a bigger and brighter star. To my friends and readers, my best wishes for success and happiness and may the star you select shine brightly, and irresistibly beckon you on to ever greater heights. —G. F. N.

ABSTRACTS

How to Produce More Ideas

Questions are great unlockers of ideas. "What if" and "What else" are two of the most important questions in any reportoire. Problems should be attacked with a persistent barrage of questions. The answers created are the alternatives for possible solutions.

A set of guide questions will help to suggest and seek out ways to solve problems:

1. What else can it be made of . . . Can it be modified? Where else can this be done? Could the package be used for something afterwards?

2. What if this item were larger . . . higher . . . longer . . . wider . . . thicker? How about extra value? Can this be increased? What if the item were enlarged?

3. What about making it more compact . . . Suppose this were left out. Can it be made smaller . . . shorter . . . thinner . . . lower? What if it were made lighter or faster? Does it need all these features?

4. What if this were turned upside down . . . inside out . . . reversed? Can cause and effect be reversed? Is one possibly the other? What if the order were changed . . . What happens if it were turned around?

5. What can be substituted? What is similar to this but costs less? Can a vendor supply this for less? What other materials would do this job? What other layout might be better? What other power would work better? Can a standard product be found which will be usable?

6. What other method or shape would improve its operation or efficiency? What does this part do? How would it be designed if it were to be built elsewhere? Should it be put on the other end or in the middle? Would this be better symmetrical or asymmetrical? Should it slide instead of rotate? How could this be changed for quicker assembly? How could this be made easier to use? Can it be done piecemeal? How much of this is the result of custom, tradition or opinions? Why does it have this shape? Can motion be added to it or is it better standing still? Can it be made safer? In what form could it be—liquid, powder, paste or solid, rod, tube, triangle, cube or sphere?

7. What do others outside this field do in a case like this? Has a search been made of the patent literature or trade journals? Is it already being supplied by another source?

When an idea is created that sounds uncommon and maybe impractical, it should be examined for benefits and reasons why it might work. It is always easy to find things wrong with any new idea. Creative imagination is needed to find the good points in an idea and apply them to specific manufacturing problems.

Abstracted from, "How to Produce More Ideas," by James A. Houle, Field Service Engineer, Minnesota Mining & Mfg. Co., Detroit, Mich., The Tool Engineer, April, 1957. For a recent article on a related subject see "Value Control—Next Step for Value Analysis," May 1957, page 000.

Management of Large R & D Organizations

In a rapidly growing organization, the major problems are those of obtaining outstanding engineers and physicists, holding onto them after they are obtained, organizing them into an efficient organizational structure, and then managing them effectively.

What Engineers Want

The best way to get and keep a topnotch man is by discovering what it is that he really wants, and then equal, if not beat, one's competitors in giving it to him. Incidentally, this is much easier to do if management has come up through the engineering ranks and not only understands but is composed of engineers.

How important is a high salary to an engineer? Undoubtedly, it is quite important.

Because of our high income taxes, today's corporations are providing an ever increasing percentage of total income in the form of fringe benefits which are not taxable, or which enjoy lower tax rates. Stock option plans are extremely popular these days. Company-financed retirement plans, longer paid vacations, added sick benefits, and larger insurance policies are the rule of the day.

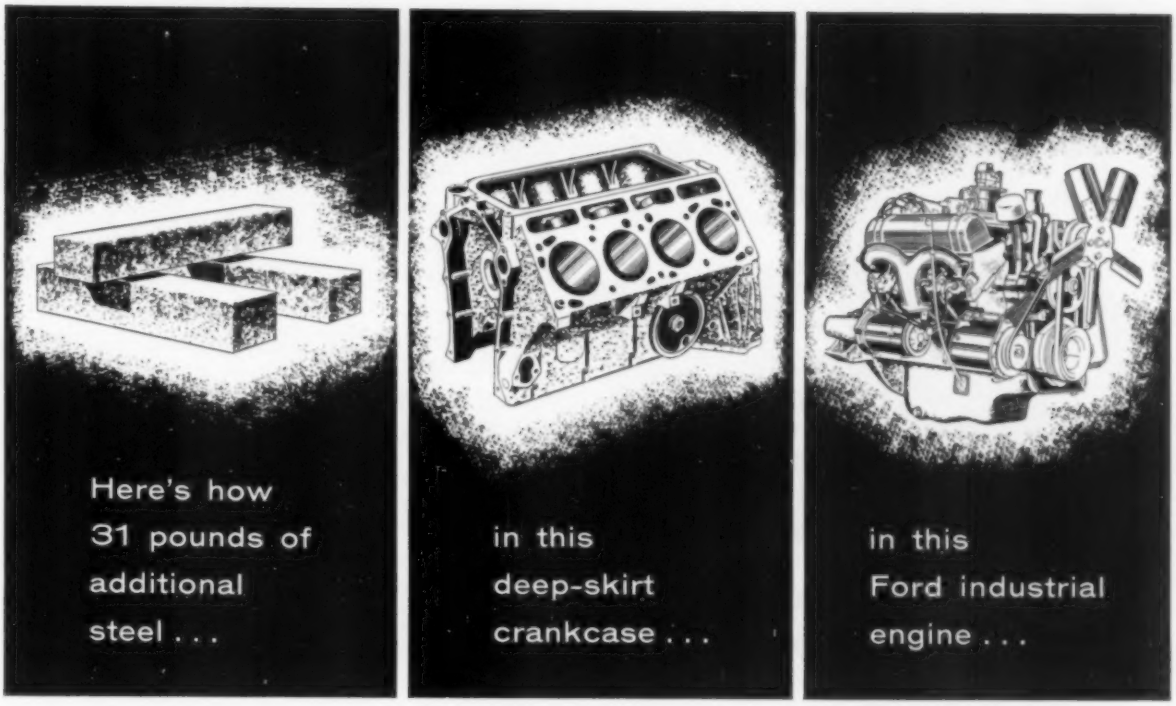
Income is clearly an important factor in obtaining and keeping a high grade technical staff. However, its importance in comparison with other factors should not be overestimated. It is observed that certain engineering organizations which are noted for paying substantially higher than average salaries also have higher than average turnover ratios.

A salary curve system has been found to be a valuable aid in maintaining a uniform salary structure throughout a large organization. A family of salary curves may be used in which salary is plotted against experience in years. The various curves represent persons of varying capabilities, and once a man is established as belonging on a particular curve, the amount of each periodic salary increase is automatically established. A man's rating may of course be changed if it appears at any time to be out of line with his abilities. The department heads should compare notes with each other occasionally so as to have uniform ideas as to what constitutes a 75 man or a 90 man. The salary curve structure, along with departmental salary budgets, forms a superior method of salary control.

In considering what an engineer really wants, interesting work and lots of it ranks high on the list. The engineer who is given a steady flow of work for which he receives adequate recognition, seldom goes around looking for another job. In this connection, however, he wants to see evidence of advance planning, research, new proposals, and the like so that he feels assured of his future. It is most important that management keep its engineers adequately informed, not

(Continued on page 411)

"I maintain that these little differences of opinion are what tend to produce more stimulating discussions—"



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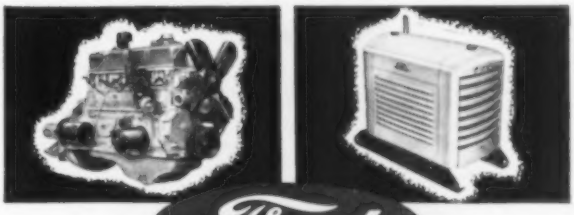

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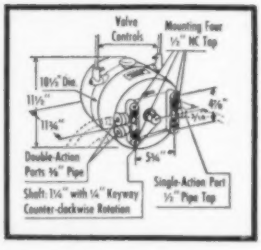
FILTER. Enclosed within Reservoir—protects all moving parts. Fine brass screen easily cleaned or changed.
DRIVE. Direct from PTO shaft, or high-speed belt or chain drives.
OPERATING RANGE. 200-1200 rpm.



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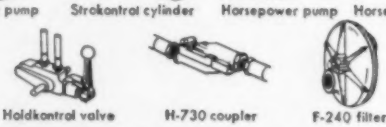
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Abstracted from "Management of Large R & D Organizations," by Nathan I. Hall, Proceedings of the IRE, April, 1957.

Development of Engineering Managers Through Planned Education and Training

The concurrent development of university and company programs aimed at advancing management capacity through formal educational techniques raises questions about the values and relations of the two approaches. The following conclusions reflect the judgments of men who have been organizers, observers, and participants in both types of programs:

1. The most valuable aspect of the university program is its assembly of a diversified group of men of outstanding performance and strong potential for further management growth. This type of program strongly emphasizes the constructive development of participants by participants, assisted, of course, by stimulation and guidance from attached faculty personnel.

2. The most valuable aspect of the company program is that it can be organized on a scale to handle all executives at selected management levels. The limited capacity of the better university programs compels

(Continued on page 413)

Designing to total dynamic environment . . .
A NEW CONCEPT in shock and vibration protection
for missiles and jets

The total dynamic environment against which equipment must be protected in missiles and jets is so violent that protection by conventional unit isolators is impractical. Unit isolators built to meet the demands of this service would be relatively huge, yet there is no room for even admittedly inadequate present-day isolators.

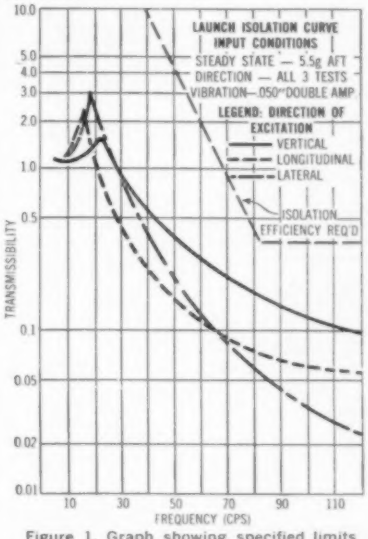


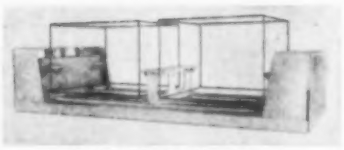
Figure 1. Graph showing specified limits of isolation efficiency during missile launching and the performance of distributed-element mounting system.

The total dynamic environment

Severe shock during launching, high *g* values of sustained acceleration with superimposed vibration, high-amplitude vibrations, and operation through all flight attitudes from horizontal to vertical — these are the elements of the dynamic environment met in currently operational missiles and detailed in the following specifications.

- Effective vibration isolation under steady-state acceleration of 6 g
- Shock transmissibility not over one for 15-g, 11-millisecond half-sine-wave shock, per Procedure I, MIL-E-5272A
- No snubber contact under high-amplitude low-frequency vibration input
- Low transmissibility at resonance
- Effective vibration isolation for all frequencies above 50 cycles per second
- Compliance with these requirements for every mounting position or attitude
- Provision of the required characteristics in an isolation system of minimum size and weight.

Obviously, MIL-spec isolators are inadequate to meet these stringent requirements.



A distributed system

A totally new design concept — a distributed-element isolation system — not only does the necessary job but provides substantial space savings as well. This is how it works. A number of small, single-degree-of-freedom, spring-and-friction-damper elements are so disposed about the mounted units that spring rates are equal for all directions of loading. This makes the isolation characteristics the same for every operating or installation position.

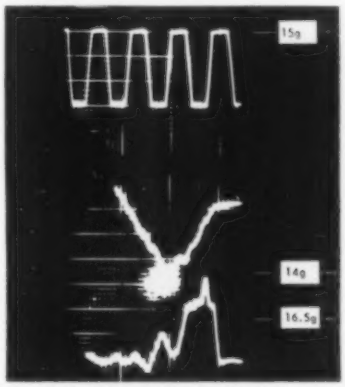


Figure 2. Oscillogram for shock test along vertical axis for an integral mounting system carrying two, six-pound electronic units. Upper trace: amplitude calibration at 60 cps. Middle trace: output from mockup of equipment. Lower trace: input to mounting assembly.

Matching the environment

With this new design concept, both the stiffness and the damping of the individual isolation elements can be selected so that the system is matched to the application. Thus it becomes feasible to provide greater shock protection in one plane, to design for different vibration inputs from different directions, or to provide whatever compensation is needed to suit the total dynamic environment. And because the separate elements can be located wherever space is available, this system minimizes space requirements.

A further advantage of this protection system is the ability to accommodate large vibration amplitudes without snubber contact. This is a result of the non-linear friction damping that can be set to limit the movement of the equipment under resonant conditions. This type of damping also allows efficient isolation of low-amplitude, high-frequency vibration because only slight damping occurs at the higher frequencies.

Additional design data

Ask for Report No. 602 giving detailed information on the specifications being met by Barry Integral Bases using the "distributed-element isolation" concept of characteristic selection.

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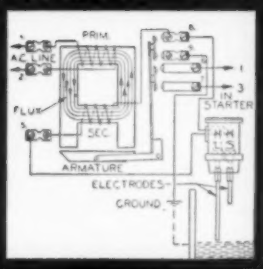
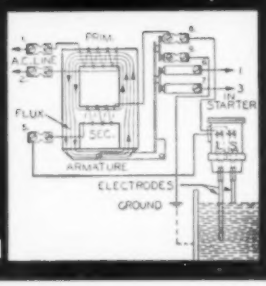


Type LH Relay for Pump Down Control



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LIQUID IS ELECTRICAL CONDUCTOR

The liquid itself is the electrical conductor that completes the secondary circuit. When this secondary circuit is completed, by the liquid contacting both electrodes, the magnetic attraction set up in the legs of the relay core causes the armature to close, and open or close the load contacts. A built-in holding circuit maintains this contact until a predetermined fall in liquid level breaks the circuit. By adjusting the electrode settings, the range of operation can be controlled.

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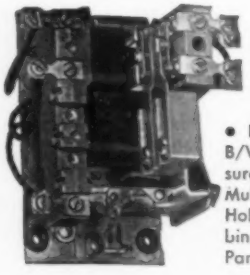

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them to restrict admission, and the desire to build diversity in each class necessarily reduces each participating company's representation to one or two men. The scale of the requirements for management development in the United States far outruns the enrollment in university programs.

3. The most serious difficulty in using university programs, beyond the absolute limitation on the number of men they can handle, grows out of the problem of selecting men of outstanding potential as participants without creating unsettling disturbances in organizational relationships and morale. Men passed up in the selection process may see the choice as a judgment of career limitation.

4. The greatest weakness in company-sponsored programs is their parochial atmosphere encouraged by the absence of men with other backgrounds than those accumulated within sponsoring organization.

These conclusions suggest that the two types of programs should be viewed as complementary rather than as alternatives. A large organization can make effective use of both, relying on the company program to assist in developing a complete horizontal slice of management personnel and on university programs for a broader development mission for selected individuals of outstanding promise.

Abstracted from, "Development of Engineering Managers Through Planned Education and Training," by M. Anshen, Carnegie Institute of Technology, Pittsburgh, Pa., The American Society of Mechanical Engineers Paper No. 57-MGT-4, presented at the ASME Engineering Management Conference, Pittsburgh, Pa., March 27-28, 1957.

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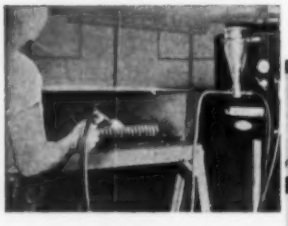
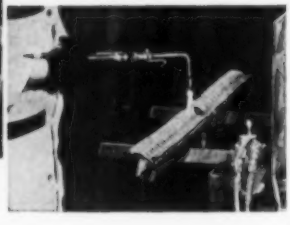


Rocker arms being sprayed with the Spraywelder.



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6 x 6 x 4	4⅞ x 4⅞	3⅛	14
8 x 6 x 3½	6¾ x 4⅞	2⅛	14
10 x 8 x 4	8⅛ x 6⅞	3⅛	14
12 x 10 x 5	10¾ x 8⅞	4⅛	14
14 x 12 x 6	12¾ x 10⅞	5⅛	14
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NEW BOOKS

Temperature Transducers

PB 121296, K. S. Lion and W. L. Harries, *Laboratory of Applied Biophysics, M.I.T., Cambridge, Massachusetts.* 8½ x 11 *in.*, 34 *pp, paperbound. Available from U.S. Dept. of Commerce, Office of Technical Services, Washington* 25, *D. C.* $1.

This report describes temperature transducers or sensing elements which produce an electrical signal that is a function of element temperature. The application of the two most widely used temperature transducers, the resistance thermometer and thermocouple is covered in detail. Also discussed are electrolytic, ionized-gas, capacitive, thermomagnetic, and noise-type transducers. The range of temperature measurements covered lies between −200 C to 4000 C.

Basic Electrical Engineering

A. E. Fitzgerald and David E. Higginbotham. 6½ x 9¼ *in.*, 540 *pp. Published by McGraw-Hill Book Co., Inc.*, 330 W. 42 *St., New York* 36, *N. Y.* $7.50.

This text presents an integrated and comprehensive introduction to electronics, measurement and control, as well as the power and machinery fields. Approximately equal emphasis is placed on the four main subdivisions of electrical engineering: circuit theory, machinery, industrial electronics and measurements, and feedback control systems. Starting with statements of the elementary electrical principles resulting from classical scientific experiments, the authors present the fundamental methods of analysis which are of greatest importance in these fields.

In this second edition new concepts are introduced in a more gradual manner and fuller explanations are presented. There is an introductory treatment of feedback control systems. Greater attention is given to sign conventions and polarity markings. New material appears on magnetic amplifiers, transistors, self-balancing recorders and controllers, phase-sensitive modulation and demodulation, control amplifiers, d-c and a-c control motors, and transfer-function and frequency-response analysis. The number of examples with complete solutions is increased and a wide variety of tested problems are included.

Laboratory Temperature Control

PB 121120, Charles M. Proctor, *Sponsored by Office of Naval Research,* 8½ x 11 *in.*, 43 *pp, paperbound. Available from U. S. Dept. of Commerce, Office of Technical Services, Washington* 25, *D. C.* $1.50.

The selection and design of a controlled-temperature bath is described in detail from research conducted through the Texas A. & M. Research Foundations. Temperature-sensing elements and regulated temperature-bath design are discussed in Part 1. Circuits for electronic relays and a mercury regulator to use with them are given in Part 2. A thermistor-operated controller, described in Part 3, allows temperature to be set by a dial and controlled to better than ±0.01 C. A protective mount for a thermistor in a water bath is also described.

Dictionary of Physics and Electronics

7½ x 10½ *in.*, 1004 pp. *Published by D. Van Nostrand Co., Inc.*, 120 *Alexander St., Princeton, N. J.* $20.

Here in one volume are definitions of the principal terms used in classical and modern physics, useful not only to physicists but also scientists and engineers in diverse fields. Prepared by an international group of scientists and educators, this dictionary has terms from 16 major subject divisions, over 300 illustrations, all designed to provide definitions needed in everyday work.

The terms defined in this book include laws, relationships, equations, basic principles and concepts, as well as the most widely used instruments, apparatus and their components. In short, this treatment comprises the terms of pure science as well as those of its applications.

The units and systems of units, so important in physics, are treated both by definitions and by a comprehensive discussion at the beginning of this book. For those who do not have an extensive mathematical background, both explicit and discursive statements and entries are given, as well as definitions of the more common mathematical terms encountered in present-day physics. All definitions, wherever possible, which have been established or recommended by professional groups are included. Many terms that have been defined from the subject-areas bordering on physics will be especially helpful.

Aircraft Hydraulics: Hydraulic Systems

Edited by H. G. Conway, *Director and Chief Engineer, Short Brothers and Harland Ltd., Belfast.* 6 x 10 *in.*, 144 *pp. Published by Chapman & Hall Ltd.*, 37 *Essex St., London, W. C.* 2, 35*s, net.*

This is the first volume of a series of textbooks sponsored by the Royal Aeronautical Society to meet the needs of students and engineers who have a background of general engineering or mathematical knowledge. Volume I is concerned with general problems of hydraulic systems: fluids, hydraulic theory from the standpoint of airplane systems, general system problems, circuits, and installation and testing problems. Volume II, to be available shortly, will cover component design, servos and piping.

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(Continued on page 417)

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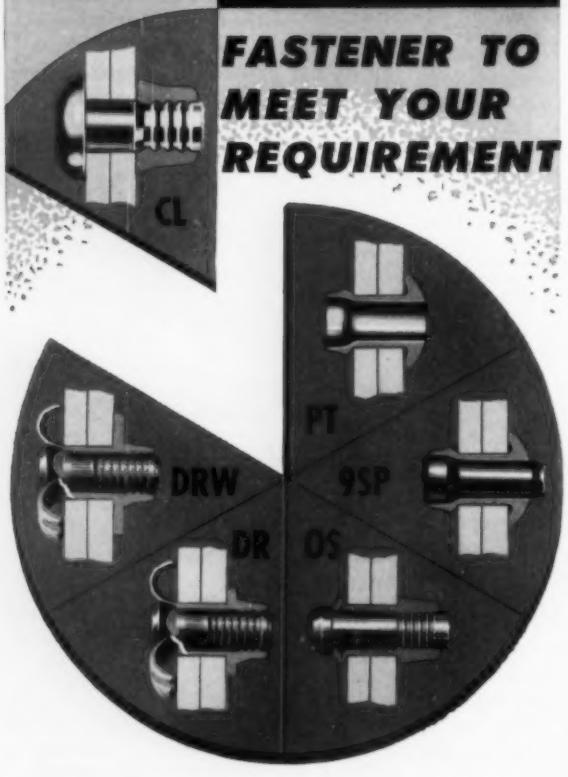

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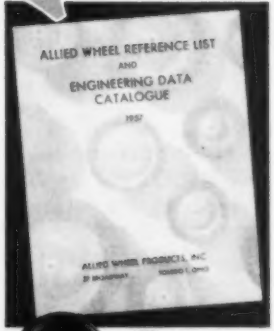

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too elementary to be of much interest to the hydraulics engineer, it is all aimed at aircraft hydraulics and examples of circuits and components provide very practical information for the designer. The last two chapters on installation and test of these systems are the only ones of their kind in the text literature and offer excellent suggestions on testing rig design and procedure.

Industrial Engineering Handbook

HAROLD B. MAYNARD, *Editor-in-Chief. President, Methods Engineering Council, Pittsburg, Pa. 6¼ x 9¼ in., approximately 1375 pp. Published by McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y. $17.50.*

Intensive concentration on cost reduction has resulted in an increasing number of cost-reducing techniques. This handbook brings together in convenient form a tremendous volume of knowledge developed in the field of industrial engineering. Each chapter has been prepared by a recognized expert in the field he discusses.

The handbook is primarily a "how-to-do-it" book for the practicing industrial engineer. It will also prove useful to management people whose work is related to or affected by the work of the industrial engineer. Its use as a reference text is obvious and, in addition, the casual reader can obtain a better understanding of the place of industrial engineering in industry.

"It isn't that you make the same mistake twice—it's that you always manage to come up with a new one!"

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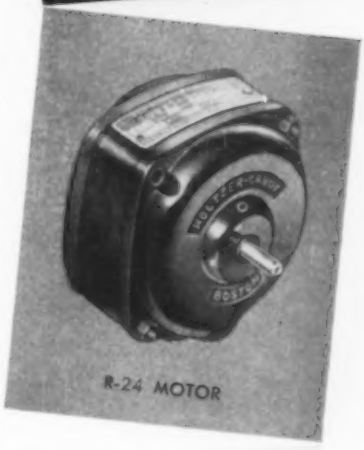

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Letters should be addressed to The Editor, *Product Engineering*, 330 West 42nd St., New York 36, N. Y.

Sources of the Bookshelf

To the Editor:

We have read your article in the March issue, entitled "The Engineer's Bookshelf," with a great deal of interest. It is very attractively done and I would assume obtained high readership among technical librarians across the country. All the more reason for our dismay at finding you had completely left out the role of the bookseller and book jobber as scientific and technical book distributors.

—Don Fitton
San Francisco, Calif.

Ed—You certainly have a point in your letter of April 16th to Mr. Koff. We should have mentioned, that particularly where book sellers like yourselves are available, it is extremely convenient for a potential purchaser to get in touch with a local book seller, rather than doing it the hard way—by mail. This is true, if he has requirements involving several publishers.

An Answer to the "Problem for Two Engineers"

To the Editor:

The "Problem for Two Engineers" stated on page 7 of the April issue is capable of solution on the following terms, which, however, require a scale of extraordinary sensitivity. Assuming that merely an academic solution is expected, this is it:

1) Identify the boxes serially, for example No. 1 to 100.

2) From box No. 1 take one ball, from box No. 2 take two balls, etc., up to box No. 100, which supplies 100 balls. All the balls thus taken from the boxes are merged into a lot of 5050 balls, which is weighed. If all the balls were exactly 1 oz each, the weight obviously would be 5050 oz. However, it is evident that the "different" box has contributed one or more balls, so that the gross weight of the lot will differ from 5050 oz by an amount (in oz) equal to 1/10 the number of balls from that box, and that the difference will be an excess or a deficiency according to whether the "different" balls are heavier or lighter than the others.

The data-interval number series article on page 178 is interesting, but represents merely another application of the "square root of 10" approach to dividing decades into smaller intervals. Many laboratory technicians are accustomed to meter scales that have a plurality of ranges in decimal multiples and sub-multiples of 3 and 10. It is true that 3.2 is a closer approximation to $\sqrt{10}$ than 3 is, but we are here trading a slight improvement in technical accuracy for a slight advantage in convenience. There is little difference in substance.

I would not like this opportunity to pass without a "plug" from me for duodecimal notation. In duodecimal notation, the quantity that splits the (duo) decades in an analogous way is 3.5 instead of 3 or 3.2, and it is closer to the ideal $\sqrt{12}$ than these other quantities are to $\sqrt{10}$. Of course, the 3.5 is really decimal notation for the quantity I had in mind, which is $3\frac{1}{2}$, or 3.6 in duodecimal notation. —William C. Schumacher
Glendale, N. Y.

Ed—Your solution to "The Problem for Two Engineers" is correct and as far as we know the only possible way to solve the problem without added gadgets. You might be interested to know that we received some rather weird solutions. One suggested placing all the boxes equidistant on a gigantic ring, then placing this on a May pole upon the scale. The tilt of the ring would show the odd weight box and the scale would determine whether it was over or under weight.

Referring to your comment about the preferred number series, meter scales that are graduated to 3 and 10 with decimal multiples and sub-multiples are exactly what came to mind when we first read this article. A little investigation showed that in actuality, such scales are graduated with the 10 mark opposite a value very close to 3.2 on the adjacent scale. It is our understanding that the dividing networks are designed to an accurate square root of 10 ratio (or as close to this as 1% resistors will permit), so that the author is really arguing for a further spread of what is already in familiar usage.

As far as duodecimal notations are concerned, we calculate the square root of 10 as 3.16, the square root of 12 as 3.46. There is really little to choose between these two as far as approximations are concerned. At this point there is considerable doubt whether duodecimal notations will ever gain wide acceptance. It had a formidable enough opponent in the straight decimal system 10 years ago. Today with binary, Gray and other codes used extensively in digital computers, there is little hope for any major acceptance of the duodecimal.

"Let's not overdo a good thing, Flotsworth!"

Rewarding the Creative Engineer

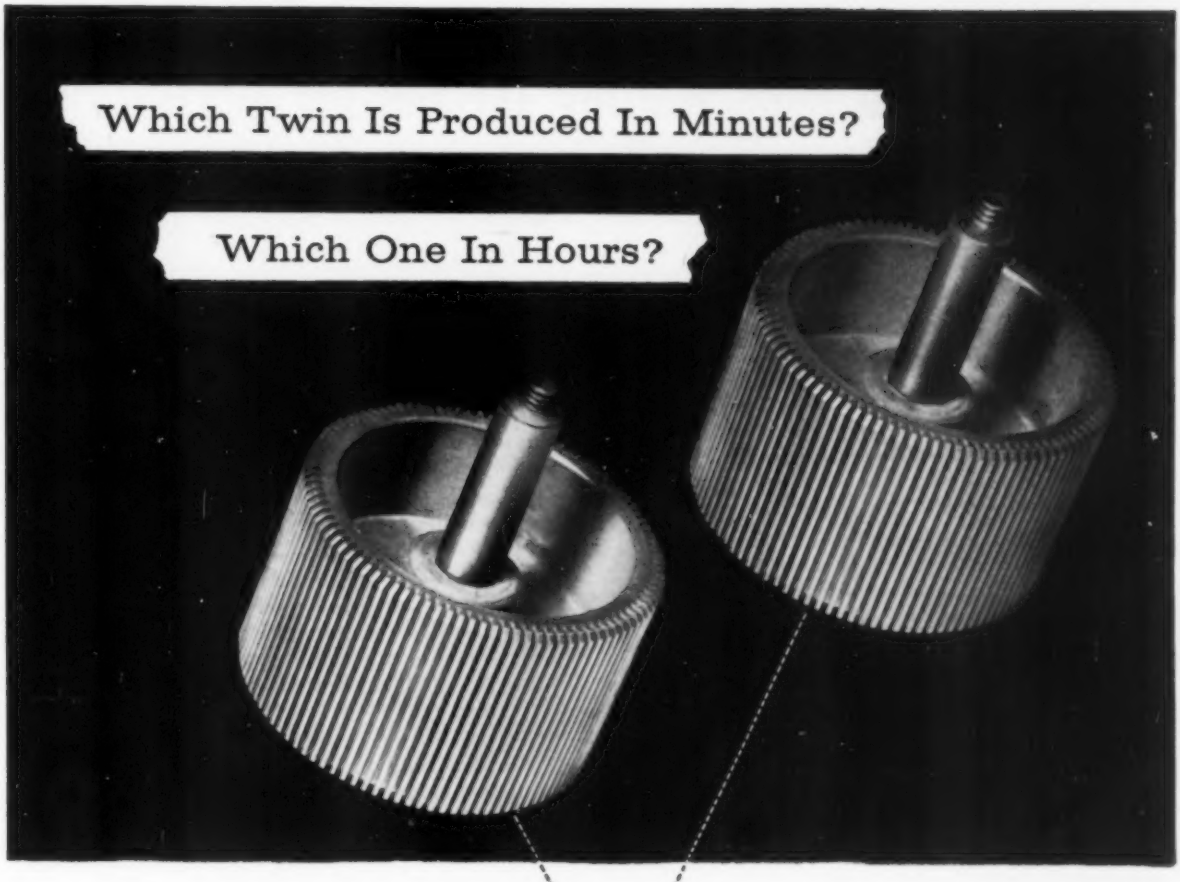
To the Editor:

Your editorial, "Raiding is not Recruiting," (Feb. issue) should have started a bit of thinking in the industry. The letter to the editor by Benjamin F. Harrison, Jr. of Ferndale, Michigan, is a good example and is to the point (March issue, page 435).

To get at the core of the situation relative to creative engineering I would like to point out the lack of incentive and the mis-handling of what is supposed to be incentive in many concerns.

For some reason engineers and scientists are trained to understand all phases of design and development without the least bit of knowledge as to what their basic rights are with respect to inventions. Then they gradually find out that most companies to whom they sell their services have built up over the past century what

(Continued on page 421)



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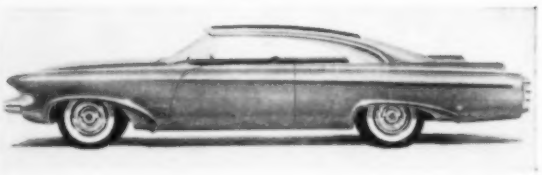
CHRYSLER Corporation
ENGINEERING Division
P. O. BOX 1118, DETROIT 31, MICHIGAN



The Norseman—Cantilever Arches Support Roof

The Norseman, revolutionary "idea" car of the future, incorporates more innovations in structure, chassis, electrical system and styling than any car ever designed by the creative Chrysler Engineering team.

Its design maintains structural strength without posts or pillars to support the roof, by means of structural cantilever arches. Power-operated 12-square-foot panel of glass in the roof slides forward, leaving rear seat area open.

All major body panels on the car are aluminum, the result of research in advanced structural techniques to reduce weight. Sharply sloping hood, upswept tail fins and smooth underbody give aerodynamic efficiency. The Norseman is designed to be powered by a special advanced Chrysler engine, with TorqueFlite transmission.

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may be called a precedent, to the effect that engineers and scientists are supposed to invent, and that it is a part of their job for which they are paid. Many engineers are instilled with an urge to rush forward with a new idea, naively believing it will enhance their standing.

It seems an amazingly short-sighted and antiquated policy when concerns insist on employees signing away their rights. Likewise, with concerns that have no such "must" agreements, yet invoke the precedent when an invention comes up.

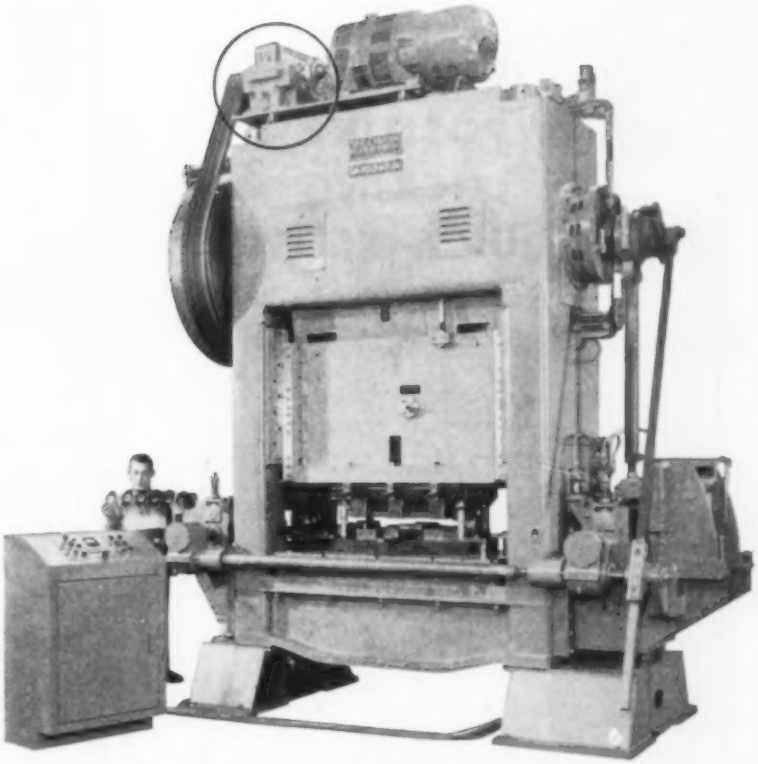
As it happens, a very small percentage of engineers are creative. If there are 1000 engineers working as a group for one company, perhaps 20 to 30 will really have good inventions during one year. The other 970 and 980 engineers are not discharged because they did not create anything—certainly not, they are needed for design! This, it would seem, would prove that engineers are not hired to invent. There are those that will say that it is pretty hard, sometimes, to tell the difference between design and invention. The answer to that seems to be the sole reason why there is a Patent Office.

After ten or twenty years of experience, the creative engineer finally learns that he can take his protected invention to an interested concern that does not know him as a mere employee, and sign up a royalty license agreement for about 5%. The concern he works for will make such agreements with a complete stranger, and make royalty payment for the life of the patent.

It is only fair to say that many concerns now have arrived at giving the

(Continued on page 423)

"It keeps following me around."



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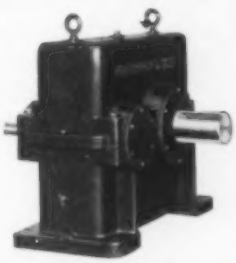
Located in the Hayes Industry Plant at Jackson, Michigan, this Flexopress has greatly increased production efficiency. Operating at double the slide speed previously obtainable, it's the world's fastest press for comparable size and stroke.



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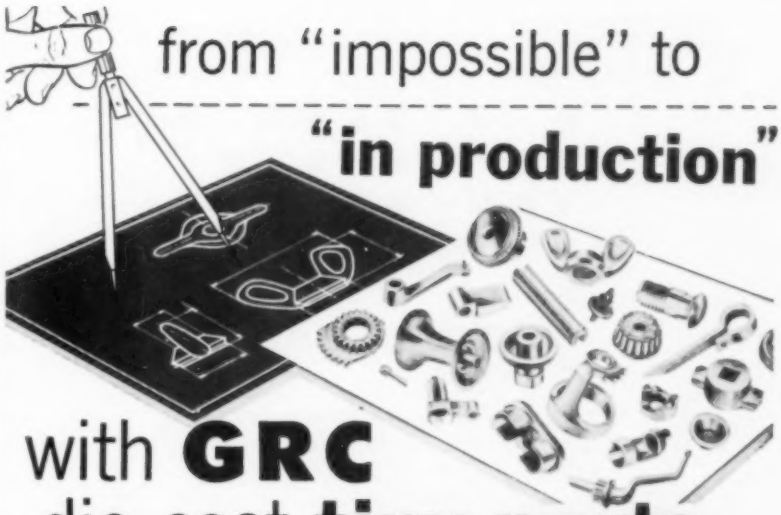
creative engineer or scientist up to 1% for a short time, instead of the past $5 or $10! These patents become valuable company assets, and are taken more seriously by management than most engineers realize.

This situation may have considerable bearing on the shortage of trained engineers and scientists, for the aggressive and practical one will remove himself from being employable by starting his own business or entering another. It would appear that organizations using such people would gain in the short and/or long run by giving all employees an agreement to the effect that they will be paid a royalty of from 1 to 3% for their creative and patentable designs. Such a voluntary agreement would provide a definite opportunity and be appreciated, it would seem, more than the various "security" offerings now in vogue which were stimulated by the unions. It has been said that opportunity made the United States what they are, rather than security.—W. E. GREENE
Hollywood, Calif.

Ed—Recently there seems to have been a trend in the direction you indicated. The first evidence was the easing or improving of payments for suggestions on company suggestion systems. The second step was recognition that foremen and other intermediate executives have a right to be paid for suggestions even though they are in line with their duties. And, if payment is made in the form of an increase in salary, it should be indicated that the increase is, at least partially, a result of their idea contributions.

The third step, the recognition of engineers' patentable ideas, is taking a little longer to be acknowledged, but it will be before too long.

"Not so fast there, O'Neil!"



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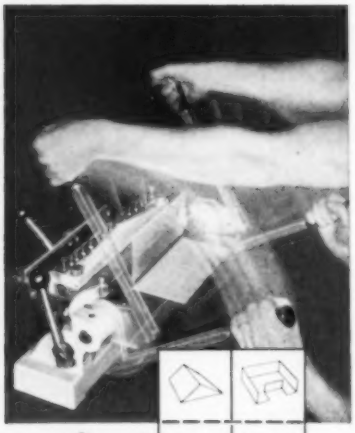

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PRESS PREVIEWS

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Allied Chemical Introduces New Polyethylene Resin for Pipe

A new form of low pressure polyethylene resin with properties particularly suited for the manufacture of polyethylene pipe will be commercially produced by Allied Chemical & Dye Corp. Pipe being made from the new polyethylene pipe compound by Orangeburg Mfg. Co., Inc., Orangeburg, N. Y., exhibits high bursting strength, resistance to impact, absence of stress cracking, superior heat resistance and resistance to chemicals, organic solvents and hydrocarbon liquids.

With an additional plant at Newark, Calif., the company will take the major part of A-C Polyethylene pipe compound production through 1957. Orangeburg has recently completed new facilities for manufacture of plastic pipe at its New York plant.

Facilities are also being installed at Buffalo to increase production of the new resin. When the production rate permits sales of the resin for purposes other than pipe manufacture, it is anticipated the new resin will have wide application in other phases of the plastics field.

New Engineering Corporation Formed

A new corporation, Era Engineering, Inc., formed by engineers with experience in the aircraft and missiles

(Continued on page 427)

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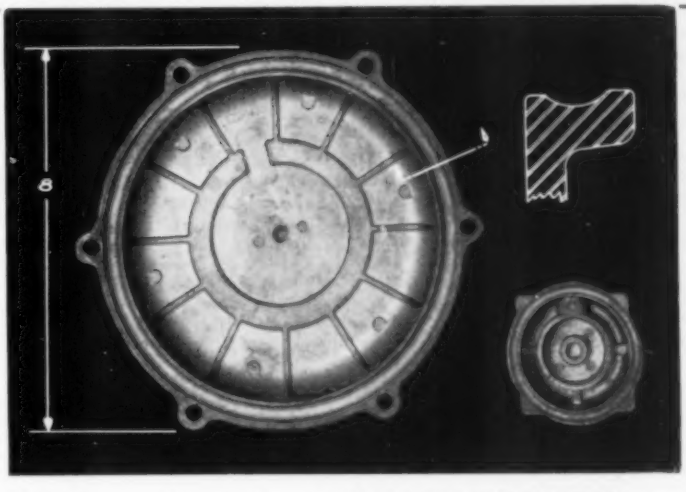

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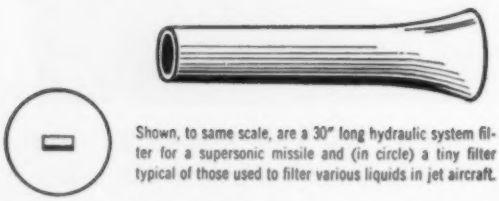
If you have a problem involving fine filtration, porous metallic filters may be the solution. Metals Disintegrating Company makes only the filter powder—not complete filters —but we will be happy to send you a list of filter fabricators.



Shown, to same scale, are a 30" long hydraulic system filter for a supersonic missile and (in circle) a tiny filter typical of those used to filter various liquids in jet aircraft.

Remember——for metal powders your best source is Metals Disintegrating Company, world's largest manufacturer of finely divided metals.

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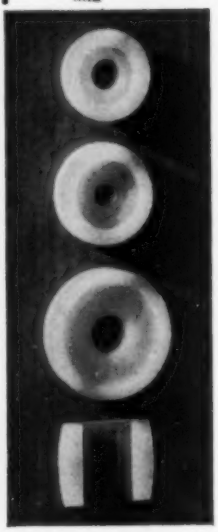

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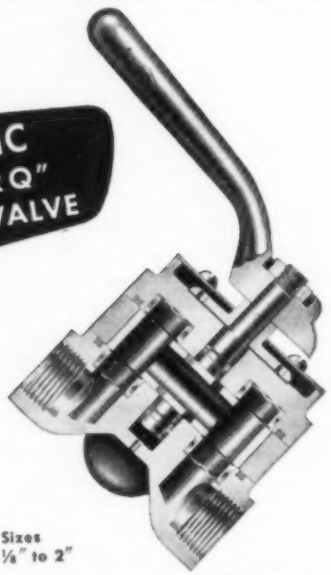

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industry to develop new systems and devices in the fields of electronics, radiation and rocketry. Office facilities and laboratories are located in Santa Monica, Calif.

Three new systems now available: (1) a simple system for measuring the distance between a missile and its target in a "near-miss" situation to assess the effectiveness of missiles under experimental firing conditions immediately after impact; (2) a device for measuring the erosion of materials on missile surfaces under hypersonic environments; and (3) a radioactive recovery technique aid in recovery of missiles and missile components after experimental flight test.

Also under development are a research rocket vehicle for aerodynamic, structures, and materials research; specific end instruments capable of operation under the severe extremes of temperature, vibration and acceleration encountered in rocket flight and a system to indicate angle of pitch and yaw.

Allegheny Ludlum to Centralize Research Facilities

Construction will soon begin on the first of three new buildings which will be built this year at Allegheny Ludlum Steel Corp.'s research and development laboratory in Brackenridge, Pa. Two buildings are already on the site, and the addition of two laboratory buildings and an administrative building this year will make it possible for the company to centralize all its research facilities at this location. The first building will house heavy research and development processing equipment, including a 500 ton forging press, a hot sheet and bar rolling mill for development work, a pilot size cold rolling mill, furnaces, a slitting and edge trimming unit, and an annealing, pickling, and coating line for experimental processing.

Plant to Produce Automation Machinery

The new $6 million factory and office building of the Cross Co., Fraser, Mich., is said to be the first all new facility in the country created solely for the production of automation machinery. The factory is laid out to provide simulated line production. Material is received at the front of the factory building, moves through machining lines, is assembled and shipped at the rear.

For assembling and testing large transfer machines that employ coolant, a special area has been set aside with a central pumping system. Cross sectionized transfer-matics up to 300 ft long can be accommodated on two of the assembly floors, or as many as 15 transfer machines can be in assembly at the same time. In one part of the office is an engineering school, which is currently graduating 16 draftsmen per year. It is expected that the school will provide the engineers needed for the company's continuing growth.

Name Changes

Universal Atomics Corp., Westbury, N. Y., has changed its name to Universal Transistor Products Corp. in order to more fully symbolize their products.

Olin Revere Metals Corp. has been changed to Ormet Corp. The previous name permitted confusion as to the exact extent of the joint effort between Olin Mathieson Chemical Corp., and Revere Copper and Brass, Inc., who jointly own Ormet Corp.

New Divisions

Beckman Instruments, Inc., through its Helipot Div., of Newport Beach, Calif., have announced the formation of a new contract engineering dept., which will specialize in the design and production of electro-mechanical subsystems for aircraft, missiles and industrial plant control equipment.

Oilgear Co., Milwaukee, Wis., has formed a Servocontrol Div. to develop and produce electro-hydraulic components.

Consolidated Electrodynamics Corp., has established a Spectron Div. for the design, development and manufacture of precision optics, including entire optical systems for guided missiles and instrumentation.

Servomechanisms, Inc., New York, N. Y., have created a Vacuum Film Products Div. for the development and manufacture of electronic compo-

(Continued on page 429)

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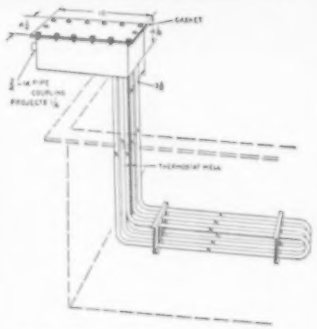

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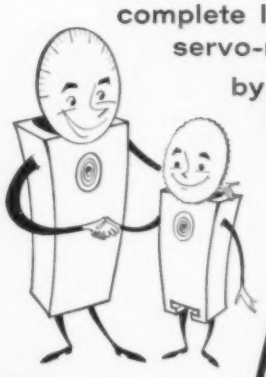
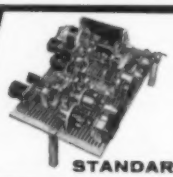


for prototype or production assemblies



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nents using vacuum film deposition techniques.

American Electronics, Inc., Los Angeles, Calif., have established a new division called American Laboratories. The new division will act as a completely independent commercial testing laboratory serving the avionics industry.

Rheem Manufacturing Co. have established an Aircraft Div. at Downey, Calif.

Hoffman Electronics Corp., have created the Hoffman Solar Div. The new division, located in Evanston, Ill., will be concerned with the development and production of solar energy converters.

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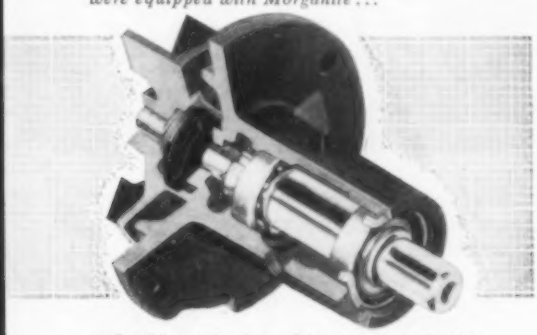

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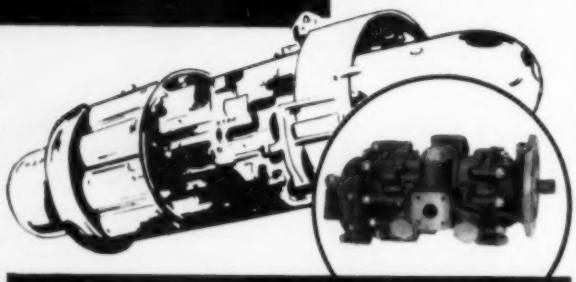

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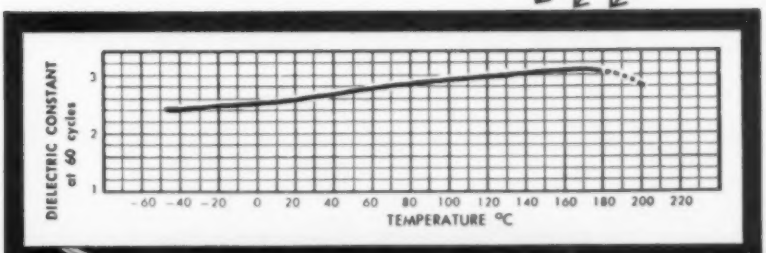

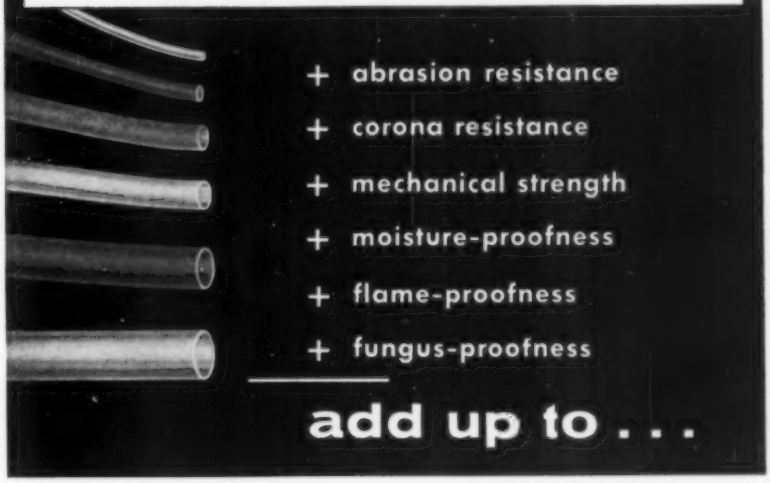

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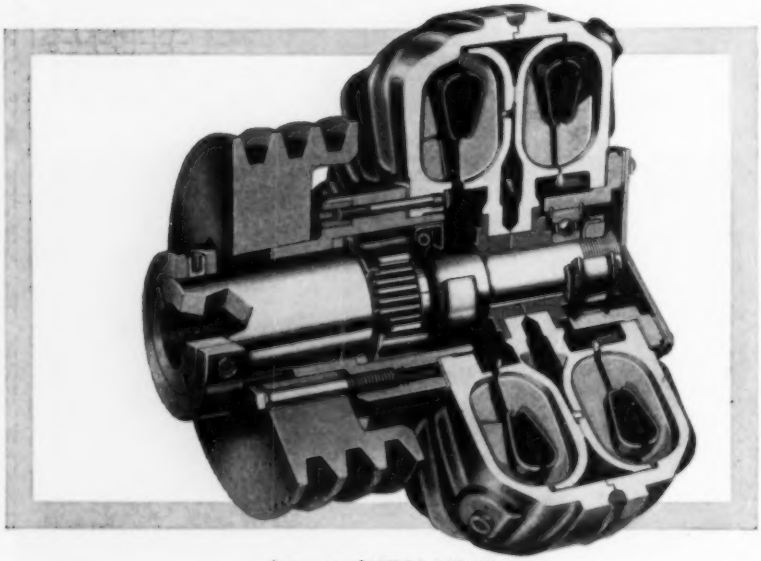

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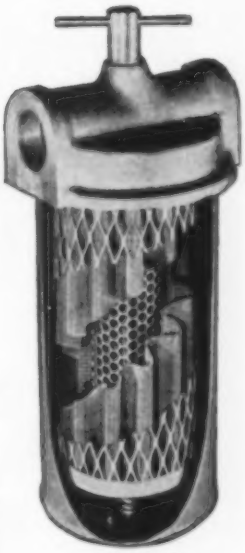
For Dependable Protection On Hydraulic Equipment

MARVEL SYNCLINAL FILTERS

Meet J.I.C. Standards

OVER 750 Original Equipment Manufacturers now install MARVEL SYNCLINAL FILTERS as Standard Equipment



SUMP TYPE (cutaway)

LINE TYPE (cutaway)

Hydraulic Oils MUST BE CLEAN to Protect Equipment— Increase Production— Reduce Maintenance

PRODUCTION ENGINEERS and MAINTENANCE MEN, whose job it is to keep production machinery operating at peak efficiency, are specifying Marvel Synclinal Filters on new equipment and standardizing with Marvels throughout their plants.

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Available for sump or line installation in capacities from 5 to 100 G.P.M. Greater capacities may be attained by multiple installation (as described in catalog). Choice of monel mesh sizes range from coarse 30 to fine 200.

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As in the past, Marvel continues to offer IMMEDIATE DELIVERY.

FILTERS FOR FIRE-RESISTANT HYDRAULIC FLUIDS

Marvel's most recent development is a filter for the efficient filtration of all types of Fire-resistant hydraulic fluids.

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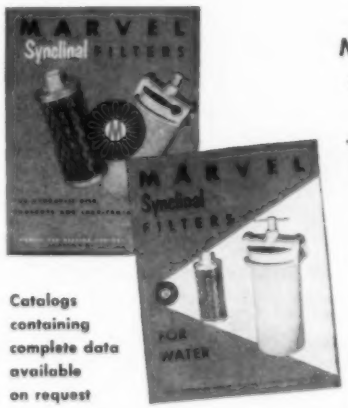
Both sump and line type filters have been adapted for use in all water filtering applications. No changes have been made in the basic, balanced synclinal design.



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PHONE: Juniper 8-6023

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- ☐ Catalog #200—For Fire-resistant Hydraulic Fluids (Aqueous Base).
- ☐ Catalog #400—For Fire-resistant Hydraulic Fluids (Synthetic).
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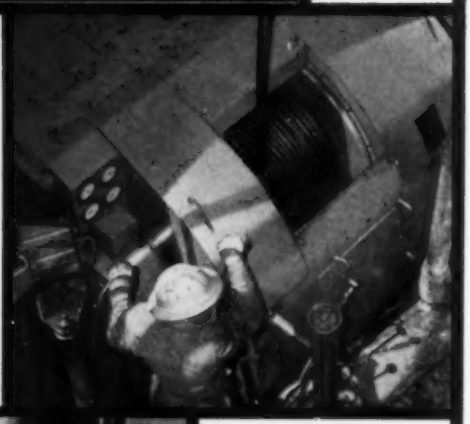
ROCKFORD

Thermoid
FRICTION MATERIALS

Stop this giant drawworks



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Thermoid is the ideal source for these and many other *friction* and *rubber* components. For 75 years, Thermoid has satisfied the requirements of design engineers for high quality, long wearing, trouble-free Hose, V-Belts, Friction Materials and Molded Rubber Parts.

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Thermoid

Thermoid Company
Trenton, New Jersey

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ROCKFORD

CLUTCH PORTS HELP HEAT & DIRT ESCAPE

Small Spring Loaded

Automotive Spring Loaded

Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

Heavy Duty Over Center

Light Over Center

Power Take-Offs

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Learn how this and other recent improvements in ROCKFORD CLUTCHES will help *your* products meet changes in modern operating conditions.

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Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

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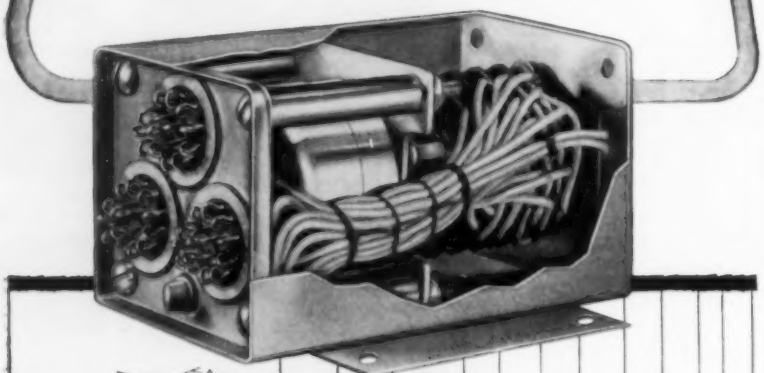
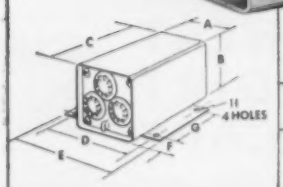
ENGINEERING B-W PRODUCTION

CLUTCHES

NEW LEDEX

HERMETICALLY SEALED ROTARY SELECTOR SWITCHES AND STEPPING RELAYS





MODEL	MAX. NO. WAFERS	MAX. NO. HEADER PINS	A	B	C	D	E	F	G	H
No. 4	4	45*	2¼"	2⅜"	4½"	2¹⁵⁄₁₆"	3⅛"	¾"	3"	³⁄₁₆"
No. 5	4	105*	3⅞"	3⅜"	5⅞"	4³⁄₁₆"	4¾"	²³⁄₃₂"	4"	³⁄₁₆"

*Circuits should allow for header pins to carry arc suppression items externally

THESE STANDARD HERMETICALLY SEALED ENCLOSURES ARE NOW AVAILABLE FOR LEDEX

Hermetically sealed Ledex switches are moisture-proof, dust-proof and protected from the effects of salt-spray, fungus and humidity. Also, many of the hermetically sealed Ledex selectors qualify for the requirements of MIL-E-5272A. Ledex selectors simplify installation problems, reduce wiring time to a minimum and prevent damage caused by tampering.

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For best delivery specify one, ten or fifteen pin headers. (Illustrated)

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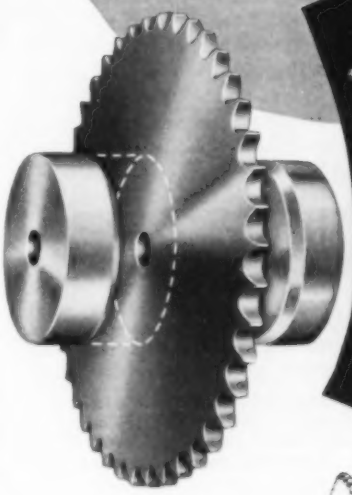
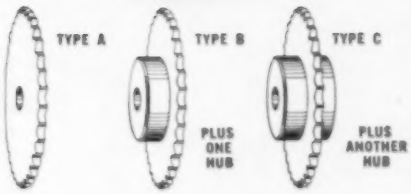
"SPECIAL" SPROCKETS

converted into off-the-shelf items...



Plates and hubs for all Cullman Semi-Stock sprocket combinations are carried in stock.



Simple as ABC, Cullman Semi-Stock converts made-to-order sprockets, in small quantities, into "off-the-shelf" stock items — cost is lower and delivery time shortened.

By welding one or two hubs to a Cullman Semi-Stock type A sprocket, it can be converted into a type B or type C sprocket. Finish machining and bore sizing complete the sprocket to specifications. Or purchase plate sprockets separately.

Various pitches and number of teeth may be combined with different hubs to supply sprockets with bore sizes according to each individual need.

cullman
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ROLLER CHAINS AND SPROCKETS

66574

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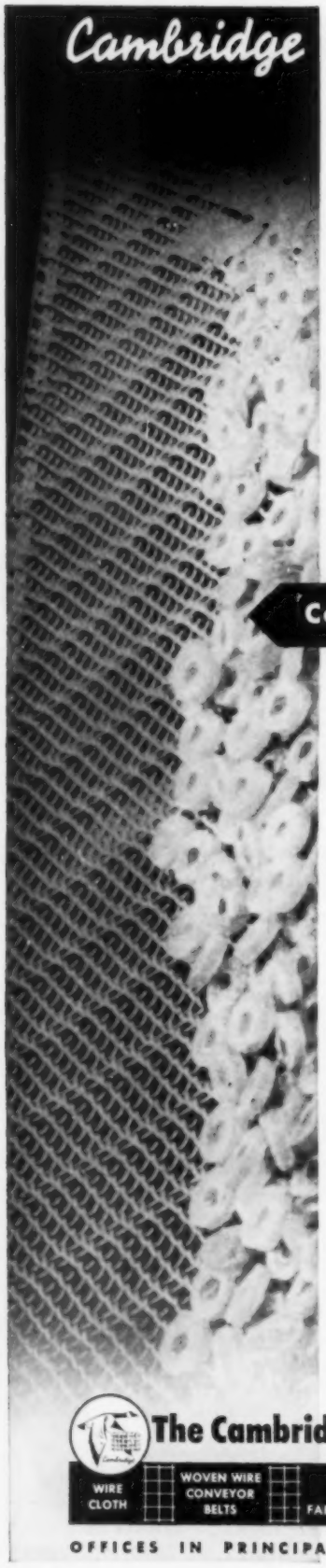

Cambridge

Woven Wire Belts give you fast, economical processing

Using woven wire conveyor belts to move products through all phases of your manufacturing operation helps speed processing and cuts costly batch handling. Food products, chemicals, plastics, metal parts, ceramics or glass can be treated faster and easier with a continuous belt-to-belt flow through the plant on woven wire belts. Controlled belt speeds through any type of operation . . . hot or cold, wet or dry . . . help increase product uniformity and maintain capacity production. EXAMPLE:

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MOVING BELT carries hot candy through cooling tunnel in a steady stream. Free circulation of air through open mesh speeds cooling process.

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Cambridge Woven Wire Conveyor Belts are a practical and economical means of combining movement with processing in any type of industry . . . food, chemical, metal-working, glass or ceramics . . . on all types of machines for your own operation or for resale. Cambridge Woven Wire Conveyor Belts are made in any size, mesh or weave, from any metal or alloy to do the job you want . . . hot or cold, wet or dry. Call your Cambridge Field Engineer to discuss how you can get fast, economical processing with woven wire conveyor belts. Look under "Belting, Mechanical" in the *Yellow Pages*. Or, write for FREE 130-PAGE REFERENCE MANUAL.

The Cambridge Wire Cloth Co.

Department P, Cambridge 6, Maryland

WIRE CLOTH | WOVEN WIRE CONVEYOR BELTS | WIRE CLOTH FABRICATIONS

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HIGH SPEED INDEXING

THE FERGUSON DRIVE

Replaces geneva drive...

INCREASES PRODUCTION UP TO 100%

Often the development of improved manufacturing methods is stopped short because the speed-limiting indexing mechanism in the basic machine prevents the full utilization of better automatic tools, feeds and processes.

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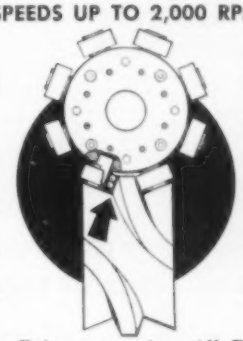

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- **FOR SUPER PRECISION ACCURACY**
- **COMPLETE FREEDOM FROM FATIGUE**

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solve performance and cost problems with MOLDED RUBBER PARTS BY STALWART

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Manufacturing plants in Bedford, Ohio and Jasper, Georgia. MAIN OFFICES: 166 NORTHFIELD ROAD, BEDFORD, OHIO

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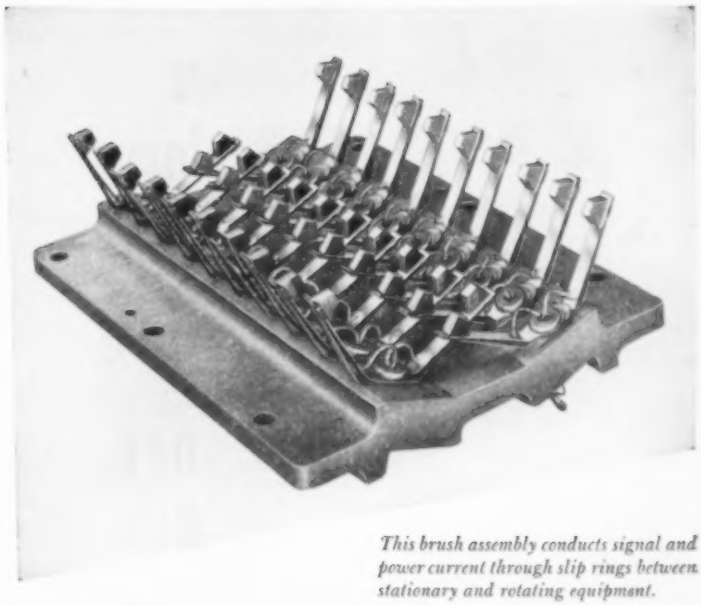

This brush assembly conducts signal and power current through slip rings between stationary and rotating equipment.

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● Trust our 37 years' experience to design and construct *specially* the *right* contact for your job. Importantly, the *material* must be *right.* From literally hundreds of grades *of our own manufacture* Superior will recommend the grade sure to give you maximum performance. Size, shape and other essentials will be *right.* Contacts, brushes, slip rings,—Superior takes on the entire project and carries it through from design to finished product. P. S.—Brand new applications intrigue us particularly.

Another Contact!

Take advantage of another contact, too. Put the Superior Engineering Department to work on your problems.

SUPERIOR CARBON PRODUCTS, INC.
9115 GEORGE AVENUE • CLEVELAND 5, OHIO

SCP

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"Since 1919"

NEW: Formsprag Sealed Clutch Series

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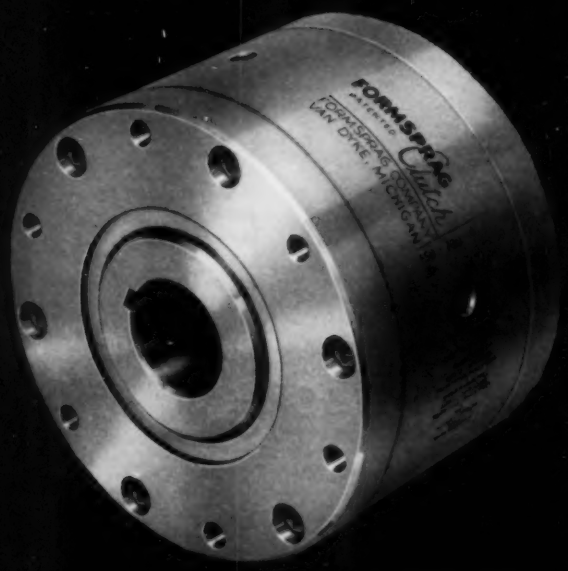


SEALS DIRT OUT

Now available—the new series "B" and "C" Formsprag Ball Bearing Sealed Clutches—designed for backstopping, indexing and low speed over-running where inner race over-runs.

The "B" is intended for over-running applications where both races rotate during some portion of the operating cycle. The "C" series should be selected if the application is one of indexing or if the outer race is to be fixed, as in a backstopping application.

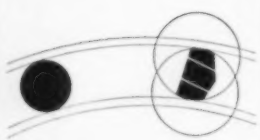
Available in bore diameters ranging from 2¼" to 5½", these new clutches have torque capacities from 1875 to 11,600 ft.-lbs. So you get unusually compact power transmission, the ultimate in accuracy, and exceptionally long service life. What's more Formsprag clutches may be reconditioned twice before obsolescence at a fraction of the cost of a new clutch.

CHECK THESE CAPACITIES

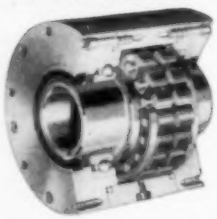
Model No.	Maximum over-running speed RPM	Torque capacity lb.-ft.	Maximum bore diameter
FSB-700	900	1,875	2¼"
FSB & FSC-750	600	3,160	2¾"
FSB & FSC-800	600	4,200	3½"
FSB & FSC-900	600	6,000	4½"
FSB & FSC-1000	500	11,600	5½"

WHY IT PAYS TO DESIGN "THE FORMSPRAG PRINCIPLE" INTO YOUR PRODUCT

Sprags are an advanced design of precision wedges made of hardened alloy steel. Utilized in a clutch, they increase the efficiency and prolong the life of all equipment using an over-running clutch or ratchet.



The sprag is, in effect, a "roller" of increased diameter with greater contact surface in a given annular space—therefore, of increased torque capacity.



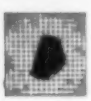
Designed for backstopping, indexing and low speed over-running service where inner race over-runs. Formsprag will make selection of either "B" or "C" series when application data sheet accompanies order.

MORE INFORMATION?

Should you require details on these Formsprag small clutches as well as the complete line, write today for this new 26-page catalog.

Over-Running, Indexing and Backstopping Clutches for aircraft, automotive and various industrial applications

FORMSPRAG COMPANY



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To get more data about new Components, Materials and Parts fully described on pages 220-393, just circle the appropriate key number.

To get more information about advertised products, circle the page number of the advertisement in which you are interested. If more than one advertisement is located on a single page, letters preceding number identify each advertisement. Key: T—Top; B—Botton; R—Right; L—Left; TL—Top left; BL—Botton left; TR—Top right; BR—Botton right.

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11—Threadless Pipe Fittings
12—Automatic Chart Reader
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125—Pocket Calculator
126—Vernier Device for Setting Dividers
127—Small Volume or Laboratory Pump
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138—Boron Stainless Steel, 8 pp. Superior Steel Corp.

139—Teflon Wire and Cable, 30 pp. American Super-Temperature Wires, Inc.

140—Hydraulic Cylinders, 10 pp. Vickers, Inc.

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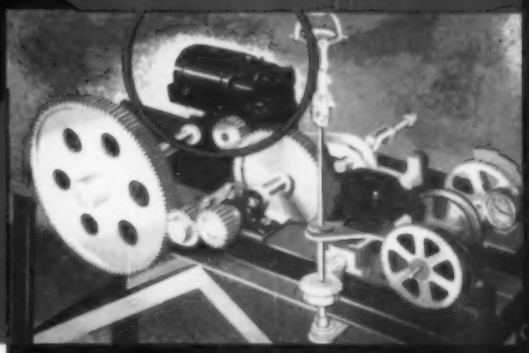

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You may not need clock drives, but time (production time) is a problem everywhere—and that calls for the most dependable, most efficient use of electric drives—like here! This clock, with 300 lbs. of hands and four 24-foot dials is powered by a Master Gearmotor driving a precision gear train. With that accurate Master drive, here's a one-jewel clock!

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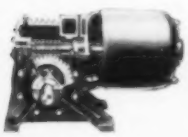

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Construction	Open, enclosed, splash-proof, fan-cooled, explosion-proof, special purpose.
Speeds	Single-speed, multi-speed, and variable speed.
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Power Drive Features	Electric brakes (2 types)—5 types of gear reduction up to 432 to 1 ratio. Mechanical and electronic variable speed units—fluid drives—every type of mounting.

THE MASTER ELECTRIC COMPANY

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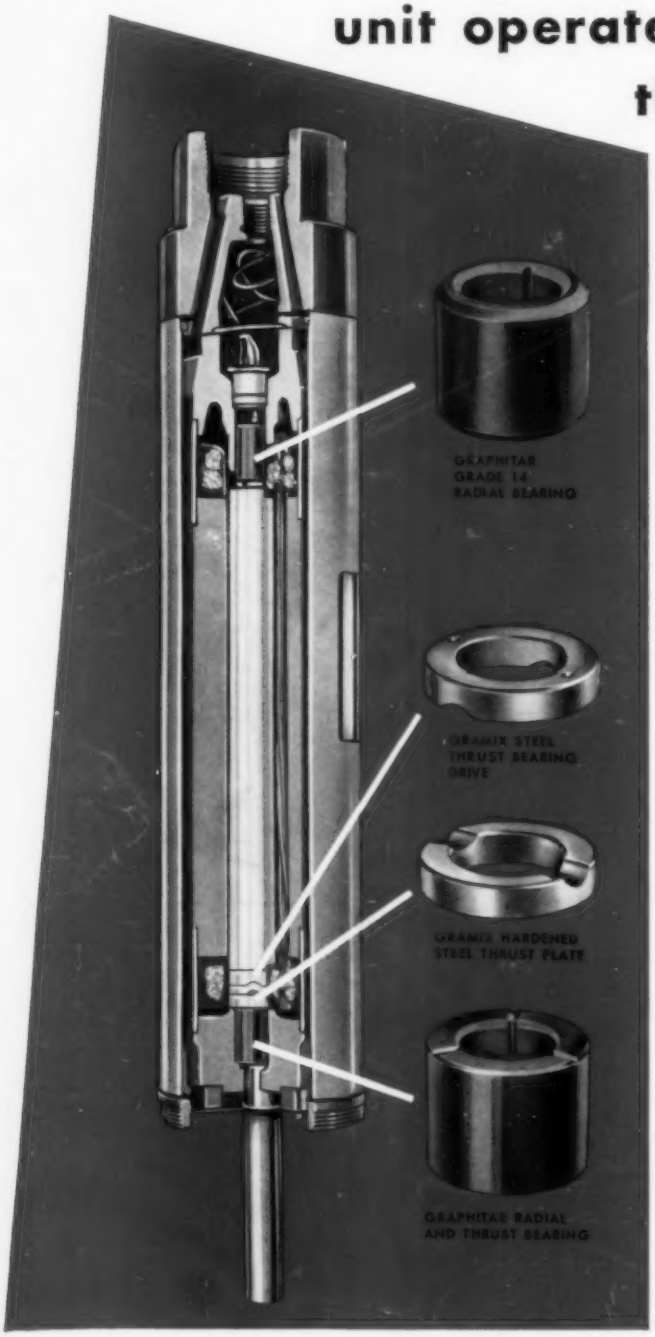
bearings in Leland submersible motor unit operate with gasoline as the only lubricant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GRAPHITAR RADIAL AND THRUST BEARING

Running directly in gasoline, this superbly-designed Leland submersible motor embodies two GRAMIX thrust washers and two GRAPHITAR bearings to keep the operation of this amazing explosion-proof pump motor safe and smooth.

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